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The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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The Genesis of Mechanised Foundry Practice

Last week we printed a full account of the progressive mechanisation of the foundries of Newman, Hender & Company, Limited, of Woodchester. It is by no means an isolated example, and similar instances could be cited in many other districts. This progressive method of mechanisation, whilst admittedly introducing drawbacks, does carry real advantages, as throughout the factor of elasticity is maintained, and it affords the management an opportunity of tuning in each separate development to the general harmony of production with a minimum of discord. Such planned progress is worth the attention of the smaller concerns, as they, too, can pursue a fixed policy of graduated modernisation without resorting to a complete reconstruction. In every case of this character proper regard must be given to the normal conduct of the plant, and at no period of the re-equipment must untidiness, let alone chaos, supervene. There must be constantly borne in mind a complete picture of the final lay-out of the foundry, and reliance must be placed on the dictum that only the best is good enough for the foundry, and a prolonged period may be necessary before the final goal is reached. Each type of foundry has its special problems. Some have difficulty in connection with the interval necessary for the drying of the moulds, for in most cases diversity of size and quantity acts against any real attempt at synchronisation. In other cases, the variable demand for sand renders its continuous production difficult. Finally, the incidence of loam, dry- and green-sand moulding carried out in the same shop is not helpful to a management keen on modernising efficiently. If, however, one or more knock-out places can be established and use made of reversible conveyor belts for feeding a central sand-preparing plant or several plants, a real start has been made towards more methodical production methods. It does appear from our observations that, once an effort is made towards the mechanisation of a section of a foundry, that effort never remains static, but tends to extend to other parts.

Full Steam Ahead

It is not part of our duty to comment on political matters, but now that the General Election is over, and in view of the national character of both the last Government and its successor, we may be permitted to express satisfaction that the progress began under the last Government will be continued virtually without change. British democracy is at once the envy and the despair of foreign observers, and every election adds a brick to the edifice of our political development. Only on three occasions, all under the shadow of some crisis, has a greater majority been returned, and that it should have been given to a government already four years in office is unprecedented. Two points have escaped general comment, both important. The first is the complete failure of the extremists of both wings, Fascist and Communist, to make any impression on the country, in spite of the unemployment problem. The second is the virtual reversion to the two-party system, for only the Labour Party could provide an alternative to the present Government, owing to the smallness of other parties.

The trade returns continue to give evidence of this progress. Every month has shown an advance over the previous year, itself better than the one before it. The October figures were the best for exports since the end of 1930. The country has regained first place among the exporting nations, and our total exports have gone up nearly one-fifth since the worst of the depression. The exports to Empire as compared with foreign countries are approximately in the ratio of two to one. At the end of 1931 there was an adverse trade balance of over three hundred millions. This year our "invisible exports" will probably pay for the excess of our imports, over two hundred millions on ten months' working. Iron and steel exports for the ten months of 1935 are up by nearly six and a-half millions over 1933. These figures are all the more striking when it is remembered that under a tariff system it was expected that we should have to make the most of our own home market. Altogether the results are highly encouraging, and there is no sign yet that the rate of progress is halting.

XUM

Properties of Grey Cast Iron as Affected by Casting Conditions

The effect of maximum heating temperature on the physical properties of cast iron is being investigated by the U.S. Bureau of Standards. The strength of cast iron is known to be a function of the amount and distribution of the graphite present and also of the structure of the ground mass. From a theoretical consideration, the maximum strength is associated with small globular graphite flakes in a pearlitic or sorbitic matrix. The structure is largely controlled by composition, melting practice, and heat-treatment of the casting, as has been found by many investigators.

The methods and results obtained in a study of three types of cast iron are briefly as follow:—Four heats, all melted in a high-frequency induction furnace, were made of each type of iron with maximum heating temperatures of liquid metal at 1,400, 1,500, 1,600 and 1,700 deg. C. respectively. Four parts of transverse test-bars, each pair of a different diameter, were cast in a dry-sand mould and the following properties studied: transverse breaking load, deflection, moduli of rupture and elasticity, hardness, density and microstructure.

The density-temperature relation in the liquid state, for each of the three irons, was not affected by the degree of superheat.

The strength of a bar of given diameter was found to depend on the maximum heating temperature. In two types of iron this maximum did not occur at the same maximum heating temperature for bars of different diameter. In the third type of iron, the transverse breaking strength increased progressively up to 1,600 deg. C. for bars of all diameters.

The running quality of the irons investigated was not materially affected by the maximum heating temperature, but was found to be a function of the liquidus temperature. For any two irons poured at the same temperature, the running quality was found to be better in the case of the iron having the lower liquidus temperature.

The microstructure of the 1.2-in. bars indicated that high strength is associated with relatively small graphite flakes and a pearlitic-sorbitic matrix.—"Industrial Heating."

The New House and the Foundry Industry

Amongst the members elected to the new House of Commons, the following are connected with the foundry industry:—Mr. Joseph Hepworth, Unionist, Bradford, E., is managing director of the Bradford Piston & Piston Ring Company, Limited; Mr. A. E. L. Chorlton, Unionist, Bury, is a Past-President of the Institute of Mechanical Engineers; Sir W. Preston, Unionist, Cheltenham, is chairman of Messrs. J. Stone & Company, Limited, engineers and founders, of Deptford; Mr. C. U. Peat, Unionist, Darlington, has been prominent in the reorganisation of the iron and steel industry; Mr. Gilbert Gledhill, Unionist, Halifax, is a director of G. H. Gledhill & Sons, Limited, Halifax, the cash register makers; Mr. A. Edwards, Labour, East Middlesbrough, is managing director of Messrs. Harrison Bros. (England), Limited, manufacturers of chilled-iron grit; Mr. F. Marshall, Labour, Brightside, Sheffield, is an ex-Lord Mayor of Sheffield and has for many years been employed in the foundry department of Messrs. Hadfields, Limited; Mr. Ellis Smith, Labour, Stoke, is an engineers' patternmaker; Mr. J. Walker, Labour, Motherwell, is an organiser of the Iron and Steel Trades Confederation; Mr. Herbert Wragg, Unionist, Derby (Belper), is prominent in the refractories industry.

District Presidents.—No. 3

MIDDLESBROUGH BRANCH OF THE INSTITUTE OF BRITISH FOUNDRYMEN

MR. A. SCHOLES, the President of the Middlesbrough branch of the Institute of British Foundrymen, commenced his professional career as a pupil with Messrs. Pattinson & Stead, the well-known firm of public analysts and consulting and metallurgical chemists, of which at that time the late Dr. J. E. Stead, F.R.S., was the managing partner. At the termination of his pupilage he was for a short time chemist to Messrs. Pease & Partners, Limited, but he returned to Dr. Stead at Middlesbrough, and eventually, in 1923, became a partner in the firm.

MR. A. SCHOLES

Mr. Scholes is a Fellow of the Institute of Chemistry, a Bronze Medallist in the City & Guilds of London Institute (Iron and Steel Manufacture, Honours Grade), a Member of Council of the Cleveland Institute of Engineers, and among other appointments is joint Public Analyst (with his partner, Mr. E. W. Jackson, F.I.C.), for the North Riding of Yorkshire and the County Borough of Middlesbrough.

During the ordinary course of their personal activities, apart from chemical analyses, problems of metallurgical interest or dispute are frequently being submitted to Pattinson & Stead for solution or opinion—amongst them being many instances relating to modern foundry practice.

(*Concluded from next column.*)

copper goes into consumption regularly on the Continent. The sanctions which have been invoked against Italy may result in copper destined for use there being diverted to this country, and in that event registration of the brand on the London Metal Exchange might well proved a distinct help. After all London is an open market where sales may always be made and "distress" parcels are no new thing in Whittington Aveune!

SHIPMENT HAS BEGUN of 24 locomotives, manufactured by the Vulcan Foundry, Limited, Newton-le-Willows, for Chinese Railways.

Brands of Repute

BY "ONLOOKER."

The days since the end of the war have seen many changes in the conduct of affairs in the non-ferrous metal trade, both in commercial and technical practice, and among them must be noted the fact that, generally speaking, manufacturers are working on a smaller range of brands than they used to do twenty years or more ago. One explanation of this lies in the insistence by the metal worker on a product which will work more easily and keep costs down to a minimum, so that the maker of brass and copper sheets, for example, must pay every attention to the excellence of his raw material. High-grade spelter, produced by an electrolytic method, is now very widely used by the brass trade in preference to the ordinary G.O.B. brands, which have been largely supplanted by debased high-grade assaying 99 per cent. for the lower-grade work. In copper matters have not fallen out in quite the same way, for, actually, the last decade has seen a big jump in the popularity of fire-refined copper, which, both for electrical work and for brass making, has to a great extent displaced electrolytic. In Bessemer brands there has, however, been a notable uplift, and the quality to-day is infinitely better than it was some years ago.

These changes on the technical side have obviously closed the door to many brands that used to find their way to this country, while the application of a duty on foreign lead and spelter in 1932 further cut down the range by limiting imports for consumption to supplies of Empire origin. No tax was imposed on copper, but consumers gave a general undertaking that they would as far as possible purchase British material, and in consequence Canadian and Rhodesian products have been much in evidence. Recently the duties on lead and spelter have been revised, and the result of this should be the arrival of more foreign metal and the re-appearance of some old friends, but so far there has not been much sign of the Empire brands being ousted. However, perhaps in due course a change may take place.

One result of the narrowing down of the buyer's choice of "names" in purchasing his metal has been that some of the fads and fancies which used to compel a decision have perforce gone by the board, and manufacturers have been compelled to admit that after all there was not very much to choose between the different brands. However, prejudice does still exist, especially perhaps in copper, and sellers find that what is a favourite with one works is anathema to another. For this the practical man is often responsible, and one finds that a foreman or charge hand will often express in no uncertain language his opinion of a particular brand! "Give a dog a bad name and hang it," is a proverb certainly applicable in this instance but ninety-nine times out of a hundred it is wrongheadedness and not conviction which condemns, for metals in any particular class to-day all conform to a high standard of excellence.

The London Metal Exchange of course has a list of official brands, at least as far as copper and tin are concerned, these, and only these, being deliverable in fulfilment of standard contracts. In copper we have electrolytic, best selected and tough, which between them furnish a goodly list of names, many of which are not familiar to the younger generation, for the days when they were in general use have long gone past. Moreover, a producer may decide to register his brand in Whittington Avenue in order that, should the need arise, physical metal may be delivered against a sale of standard copper, but in the ordinary course of events it is quite possible that this particular brand of

(*Concluded in preceding column.*)

Slush Pump Piston Cores Produced by Centrifugal Casting Process*

By A. E. FALK, Torrance, Calif., U.S.A.

For the past four years, the company with which the writer is connected has had in successful operation a small grey-iron foundry, in which 90 per cent. of the castings are centrifugally cast. These castings are cores for a rubber piston used in slush pumps. The tremendous loads carried by these cores in service caused many formerly purchased from outside sources to crack and allow the piston to become loose on the rod. To overcome these difficulties, the firm decided to install its own foundry, using an electric furnace to produce a high-strength iron, and spinning the cores to produce a finer-grained iron. This meant the development of the centrifugal device itself, of suitable moulds, with correct spinning speed and a satisfactory core pin.

The centrifugal device is set in a pit, and consists of two bowls mounted on opposite ends of a pivoted frame. Over one end of the pit is a platform supporting the ladle and pouring spout; on the other end, a man is stationed to change moulds with the aid of two air hoists. One hoist lowers an empty mould into the bowl. This bowl is then placed in pouring position by revolving the pivoted frame through an 180-deg. arc. This places a filled mould in front of the operator. The filled mould is taken from the bowl with the second air hoist, and an empty mould is again lowered into the bowl with the first hoist. This change is made while the spinning mould on the opposite end of the frame is being poured. As soon as this mould is filled, the frame is again indexed through an 180-deg. arc and the process repeated. The bowl with its mould is brought up to 600 r.p.m. when starting to pour. Higher spinning speeds were formerly used, but it was found that lowering the speed gave better mould life.

New moulds are brought into position to be handled by the hoist and filled moulds taken away by small cars running on an oval track which crosses the centre of the pit. Using the two bowls, changing the moulds in one while the mould in the other is being poured, 12 to 15 castings can be poured in 4 to 5 min. The filled moulds are allowed to stand from 3 to 5 min., to allow the metal to set, before being sent to the stripping machine, where the mould is pulled apart and the casting removed. The total time, from the pouring of the first casting until the last casting is in the annealing oven, will average about 15 min. Fig. 1 shows the general lay-out.

Development of the Moulds

Perhaps the most difficult problem involved was the development of the mould. In the first moulds, the casting was poured in a vertical position. This was soon given up, as it was hard to hold the core in position, and machine costs on the moulds were prohibitive. Moulds were then made in which the casting was poured in a horizontal position. This method cut machine costs and produced a casting with an extremely close-grained iron in the hub, where the strength is needed.

Moulds are now cast in two halves, a male and a female, and then machined to the size casting desired. The halves of the mould, the core pin and a casting are shown in Fig. 2. The outsides of the moulds are finished with a taper which corresponds to a taper in the bowls. This wedges the halves together and holds the mould in the bowl while spinning. The first moulds were made of steel. Although they gave fair results, their tendency to burn in and warp made their upkeep cost prohibitive. Various steel alloys were used, but the results were about the same.

Cast-iron moulds were then tried and found to be much more satisfactory. Machining costs were cut materially, and they did not warp, but a new difficulty appeared. The moulds fire-checked. To overcome this the moulds were machined out and new linings threaded in. This gave fair results, but the linings soon came loose and the moulds had again to be relined. The number of castings produced on each lining was too low for the cost involved. Alloy irons then were tried and found to give much better results. Many alloy irons have been tried, but only two have given satisfactory results. The first of these contained 3.50 per cent. carbon, 3.90 per cent. Si and 0.80 per cent. Mn. The second had a composition of 3.20 per cent. total carbon, 2.30 per cent. Si, 3.50 per cent. Ni, and 0.50 per cent. Mo.

The first iron is made of straight pig-iron with silicon raised 1 per cent. The second is made of iron as used in production of cores with the addition of nickel and molybdenum. The addition of molybdenum has been found to decrease the fire-checking, but will cause a mould to crack unless heat-treated so as to relieve all strains. All moulds are cast in a permanent mould and annealed to facilitate machining. This permanent mould is always set up, and as the end of the day's run draws near, any extra iron is used for moulds, the nickel and molybdenum being added as ladle additions. Their ease of casting and machining makes them by far the cheapest to use. The moulds are all annealed at 955 deg. C. for 2 hrs. and then left to cool in the oven. After machining, and just before placing in service, the moulds are again heated to a dull red. All new moulds are placed on the end of the string so as to receive the coldest iron. After five or six heats they are placed in their proper position, according to size. The smallest castings are poured first.

All new moulds are started on the small sizes and as they fire check they are rebored to the next larger size. Casting sizes vary from 6 in. to 8½ in. Mould life varies from 400 to 700 castings, depending on type and size of castings needed. After each rebore the moulds must again be heated to a dull red and started as a new mould. The critical point in the life of a mould seems to be in the first few castings poured. Unless all strains are relieved and the mould hot, the first castings are apt to crack it. After a mould is started, it will very seldom crack and needs no attention except a spray of wash every two or three heats. Raising the total carbon will eliminate this tendency to crack to some extent, but it makes the metal softer and this increases the tendency for the mould to flake off at the point where the stream of metal first strikes the revolving mould.

Cooling Moulds

After pouring a heat, all moulds were formerly cooled with a spray of water. This practice proved to be too much of a shock to the hot moulds and caused too much cracking and warping. The moulds are now cooled slightly by passing through an air tunnel. It has been found that the moulds give much better service if kept hot.

Pouring the Castings

In pouring, the mould is started spinning at the same time the stream of metal starts. Formerly the mould was brought up to speed before starting to pour. This caused the first metal to hit the face of the mould with great force, causing flaking off of the mould and fire checking at the points where the metal first struck the mould. In starting to pour at a slow speed this shock is eliminated, and by the time the mould is up to speed a skin of metal has formed over the face of the mould. As the mould fills the metal stream is tapered off. When filled the mould is allowed to spin a few seconds, during which time the metal can be observed to be sinking. This hollow is then filled up. On an 8½-in. casting weighing 48 lbs. a gate approximately 1⅝ in. by 1½ in. by 1 in. high is used. Due to the spinning, this casting can be made without any sign of a shrink.

Mould Wash

The development of a wash was another problem. Many types of prepared washes were used but none would stick. Smoking with an acetylene flame was the practice used for a while. However, when the moulds were smoked, there was a tendency for the smaller castings to have bubble holes on the face of the hub. It was decided that the metal in flying out against the soot-covered mould had a tendency to splash or bubble. The smoking was discontinued and the holes in the castings disappeared. A wash has now been developed that protects the face of the mould and at the same time promotes easy stripping. It consists of a diluted refractory cement, core oil and graphite.

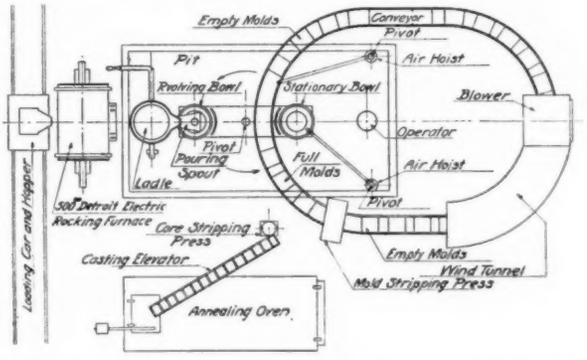

FIG. 1 (LEFT).—GENERAL LAY-OUT OF FOUNDRY.

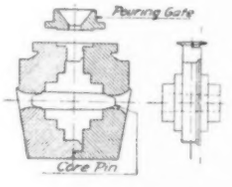

FIG. 2 (ABOVE).—CROSS-SECTION OF MOULD AND SKETCH OF CASTING.

Use of Metal Core Pins

During the pouring and spinning of the casting the metal falls directly on the core until the mould is nearly filled. Originally sand cores were used, but invariably they would wash and burn in. To eliminate this difficulty it was decided to use metal cores. Steel was tried for this purpose, but proved a failure; the pins either burned in or, due to the higher expansion rate, cracked the hub of the castings. Iron core pins eliminated cracking but not the burning-in. A high-chromium iron gave fair results, but machining costs were prohibitive. Finally, a high-nickel iron was developed that solved the problem. This austenitic iron is of low thermal conductivity and hence absorbs heat slowly, and

(*Concluded on page 382.*)

* A Paper read before the Toronto Meeting of the American Foundrymen's Association. The Author is with the D. & M. Machine Works.

Boxes and Grates*

By J. G. GOULD

All practical foundrymen know how much trouble may result from badly-designed boxes breaking or springing when in use. There is invariably much worry when there is an urgent one-off job. Expenses have to be cut to a minimum and any available box used. Boxes, well designed in the first place, help in many ways to solve the problem of alterations necessary to make them fit the job. It is suggested that all boxes over 30 in. square be cast with a heavy outer frame. The sides should be of channel section with the flanges to the outside of the box. This gives a very stiff and unyielding job. In use on floor work, sand is rammed under these flanges before the box is lifted. The necessity for packing up to take weights disappears and many crushed joints are saved. It is very easy to add an extension piece to these boxes. These pieces are made with projections, to slip along between the channel, and are secured by wedges and clamps only, no bolts being necessary. From personal experience it can be stated that many of the flat tops have been utilised in this manner for different jobs at little cost.

Now, if very heavy frames be used on boxes, precaution must be taken against breakage by the bars expanding. Light bars, relieved by having no long straight lines, are preferable. This may be done by having thin oil-sand cores placed at strategic points when casting the box, and also by staggering the short bars, as this takes up a lot of spring. A useful point is to cast projections on the bottom flange, to use as staked guides for floor work. The flanges are ideal for drilling for guides and bolts when using stacked boxes, and are very easily clamped.

Triple Lifting Lugs

Another point is to cast triple lifting lugs on the sides instead of the usual single lug. By keeping the triple lugs just close enough to allow the sling chains to be placed in position, it will be found that almost all balancing weights for awkward lifts may be eliminated. The chain being placed under the outside lugs and over the centre one, will not surge. This is a distinct advantage when knocking out the boxes, as the box hangs level the whole of the time if any ordinary care is used. If a lift be heavy to one side of the box, the triple lug is extremely handy, as sling packing need only be placed on top of the box, and not underneath as is the ordinary practice.

Large Boxes

A limit in this type of box is reached when about 6 ft. wide. After this the strength needed makes it advisable to carry the channel section round the end bars. It is suggested that loose trunnions are an advantage in the very large sizes. Holes about 3 in. dia., cast in places where the metal has been brought level with the flanges, accommodate these loose steel trunnions. If two of these holes are cast on each end of the box the stands for turning over the box may be quite low, and the overhead crane can turn the box over whilst all men are clear. The sling in this case is passed under the corner of the box before being placed on the trunnions. By the word "stand" please take a couple of heavy logs to be meant.

The Built-up Box

Many people swear by the built-up box, and this certainly has many advantages. In making this type of box, covered sand, and not open sand, castings are to be preferred for the sides. A combination of the two types is very useful, such as a box with square open centre, arranged to take a separate casting. This has the advantage of being easily removed for the reception of large bosses or brackets. A point to note, in this class of box, is never to have more than a full nut when tightening bolts. One thread under full-nut will assist when dismantling for alteration. The repetition founder, when making his flasks, often can, by making more expensive boxes, save money. The flat and square often give way to a box shaped for safe casting, less ramming and easier knocking out.

Boxes for Chairs

A case in point is that of the chairmaker's boxes. These are a fine example of the box-maker's art. Flasks, hinged at one corner and snapped at the opposite one, lend themselves well to repetition work. The castings in these need not be disturbed when the box is removed. This means a box returning quickly to use on the machine. A visit, arranged by the Institute, to the Close Works, allowed the visitors to inspect a fine type of flask. A stout outer frame was arranged to carry separate bars. These were secured by dovetails, rather similar in style to those on bedsteads. Wedged tight, these were further secured by a frame, fitting over the top of the box, being bolted by sunk bolts. These bolts were kept short as previously described. The centre boxes were arranged in heights of 5½ in., 7 in. and 9 in. A good combination of heights can be had from these.

Light Boxes

The light box, with waved bars and rounded corners, fastened by hasps, used at one local foundry, is a very good type. Storage in the open air seems to be the only point liable to criticism. Middle boxes are much stiffer and handier when made with a ledge at the top and bottom inside. Loose bars and irons are easily secured in these. Approximate strengths of boxes should be:—1 in. metal with ¾-in. bars and 5 in. deep for all crane boxes up to 3 ft. square; 1¼ in. with 1½-in. flanges and ¾-in. bars 7 in. deep up to 6 ft. square; 1½ in. with 1½-in. flange, 1-in. bars, 9 in. deep up to 8 ft. square; and 1¾ in. with 2-in. flanges and 1⅛-in. bars, 10½ in. deep, up to 10 ft. square.

Generosity in depth to all larger sizes is advisable, as this increases the stiffness. Wooden boxes have an advantage in small emergency work, but, as a rule, are not advisable except for use by a careful moulder.

Grates

The use of core oil has made the making of grates a much simpler job in most cases. A set bed for stamping out grates is very useful. One foundry recently visited by the author made most of its grates between the bogie lines. These were fairly level, and metal was snatched when the metal bogies were passing. Grates should not be made to fit tight, and should have fingers at the sides set at an angle so as to break, in preference to straining the casting. A thin, deep section is preferable for grates, as this lends itself to cutting old grates to suit other jobs. In passing, it may be desirable to mention the use of the emergency dowel and socket, illustrated on page 590 of the "Proceedings of the Institute, 1930-31." The hole in the socket must not be made tapered, as this tends to locking. This little gadget is indispensable when used in conjunction with clay guides, as it gives a micrometer fit at the last moment.

In conclusion, the use of stretchers, of different length, for spreading the sling chains, has almost abolished the use of turnover stands in the shop controlled by the writer. The stretchers are made of hard wood, with bar-iron sides bolted on, so that the sling sits over the wood and between the bars. Two short hook chains are placed at convenient points to engage with the links next to the top eye of sling. In most cases, boxes under 5 ft. are lifted in this manner, and are turned over as lifting proceeds.

* Short Papers presented to the Middlesbrough Branch of the Institute of British Foundrymen, Mr. A. Scholes presiding.

An Outline of the Application of Machine Moulding to Jobbing Foundries*

BY JOHN BLAKISTON.

This short Paper is intended to show the evolution of mechanical aids to moulding and their suitability for adapting to jobbing moulding. Machine moulding does not displace the moulder, but enables his energy and skill to be devoted to actual moulding, pattern dressing, and closing, instead of wasting his efforts in sand handling, useless labour and double work.

Ramming Board

The first mechanical aid is the ramming board, used to eliminate "bedding in." This enables sound ramming to be obtained at the bottom of the pattern, and so eliminates swells; better venting can be applied, and the pattern receives less rough usage as the moulder is relieved of the necessity of obtaining the impression by driving the pattern into the sand floor by means of a large mallet. Relieved of this the pattern is not so liable to distort.

Turn-Over Pattern Plate

The next step from this is the double-sided pattern plate, where the pattern is attached to the ramming board and is drawn up with the ramming board, after turning over, being guided by the box pins, which prevent the shake of the moulder's hand being transferred to the pattern; if the mould requires a flat top, the top box is rammed from the flat top of the pattern plate, and should the top box require an impression the pattern is divided between both sides of the plate.

Stripping Plate

When patterns are drawn from the sand a water brush is often used to prevent the top edges of the mould lifting with it. Should a portion of the sand lift, however, the moulder will press it back with his trowel. This pressing back by hand introduces the stipping plate, a plate which fits snugly round the pattern and literally scrapes the sand from the pattern. Remarkably deep and clean draws can be achieved by this method.

These fundamental moulding aids represent the first principle of all stripping methods, and ramming positions of moulding machinery.

A mould can be rammed by hand in three ways:—(1) By direct blows with a rammer, (2) by a direct tuck with the hand or fist and (3) by throwing a handful of sand at an inaccessible part of the pattern.

Method (1) may be reproduced mechanically by:—(*a*) The use of compressed-air rammers and (*b*) jolting or allowing the pattern and sand to fall and be arrested sharply. This utilises the kinetic energy in the sand to ram itself.

Method (2) is reproduced by a squeezing machine, the squeeze to be obtained by hand levers, air hydraulics or electricity.

Method (3) can be reproduced by means of a Sandslinger or sandblower.

The moulding machine may produce one or more of the preceding moulding or ramming operations. Different combinations being suitable for different classes of work. Perhaps the best type of machine for the jobbing moulder is the turn-over machine, with pattern draw. This machine is rammed by hand. The patterns can be drawn by the machine or left loose on the plate and drawn by the moulder. The main feature of this machine is the ease with which the mould is turned over and handled.

(*Concluded on facing page.*)

Co-opting the Machinist

A NEW ANGLE ON FOUNDRY CO-OPERATION

A meeting of the Lancashire Branch of the Institute of British Foundrymen was held at the Engineers' Club, Manchester, recently. There were upwards of 100 members present.

MR. J. HOGG (Burnley), who presided over the earlier part of the proceedings, in calling upon the President, Mr. J. Jackson, to deliver his Presidential Address, referred in eulogistic terms to the work done by Mr. Jackson in furtherance of the aims of the Institute for a considerable number of years past, and particularly to his efforts to promote the success of the Burnley and Preston Branches. He had also devoted a great deal of time and pains towards facilitating the technical education of apprentices, as well as being highly successful in bringing new members into the Institute.

PRESIDENTIAL ADDRESS

In the course of his address the BRANCH-PRESIDENT dealt with the dividing line between the founder and the machinist. To the whole of the workers whose efforts have gone into the making of castings, he considered that their thoughts did not at the present go quite far enough. Particularly did this apply to the foundryman, who, when having completed the making of a batch of sound castings, felt quite satisfied with a job well done.

It was now more generally recognised that much progress had been, and was still being, made in the higher branches of founding, due principally to the full co-operation of the efforts of the draughtsman, patternmaker, moulder and metallurgist; due in a large measure to the combined efforts of the various branches of the Institute that these skilled people had been brought more together, and were now working with such a hearty spirit of harmony that had enabled such progress to be made.

Viewing the other side of the picture, the Branch-President pointed out the desirability of instituting that same happy working harmony and exchange of ideas, and confidences, between the designer, patternmaker, moulder and the machinist. At present, generally speaking, there was an imaginary dividing line over which the machinist dared not tread.

The whole of the arts and sciences which went to the making of sound castings were to him a sealed book. Draws, liquid contractions, gas inclusions, and all the other multiplicity of foundrymen's troubles, were of no interest to him. Castings to him were hard or soft, sound or blown, seldom right, and, in his opinion, not nearly so good as many castings he had to work on 10 years or more ago. Yet this same machine-shop man, although he understood little, if any, of the metallurgy of metals, had a view point which was well worthy of consideration. This was particularly the case in regard to the machinability of the job. After all, the engineer and machinist thought and spoke of the finished machines. Yet it should be fully considered that a big part of the founding art was to give castings with the readiest and easiest facility for machining.

The moulder had, of recent years, been much better informed as to correct analyses, mixings, strength and good qualities of metals, and when applying this knowledge he was often far too apt to forget that the machine-shop man had not yet attained this knowledge, and when a complaint came from the machine shop, where somebody had spoken, for instance, of badly blown bosses in a job which the moulder recognised at once was a draw, due to something other than faulty moulding, the moulder should be considerate and not just view it that the machine-shop man knew no better, but, he said, try to examine it from the machinist's angle.

As an instance the Branch-President cited a bracket for a worm and worm wheel drive, having fixed centres to very fine limits for the worm and worm wheel, and also having rather robust bosses. The moulder, the patternmaker and draughtsman, would agree that coring out these bosses would ensure freedom from draws, and would yield cleaner metal in the bosses when bored, and they would feel confident the best system of making this particular job had been adopted and, from the foundry point of view, they would be correct. Yet the machine-shop man would take quite a different view, and correctly so, that the job could have been made better. In a job as above described he was up against a great difficulty in boring cored holes to keep true to fixed centres, even if boring from a jig with fixed centre hardened-bushes. If the machinist could have his way in the making of such a bracket, he would certainly have it cast with at least one of the bosses cast solid, to give him easier facility for making a true bore to the centres required to ensure a perfect gear with the respective worm and worm wheel.

Again, how often were tubes and collars made with the bore cored out, with the idea of saving machining, and when the job was finished the castings were found to be badly warped due to irregular thickness of wall, or even when the walls were regular, they were often warped due to irregular cooling. Again, the machinist preferred this type of casting cast solid, for with present-day machining methods many of such jobs were bored and finished more rapidly and certainly more efficiently when cast solid. The two jobs mentioned would suffice to illustrate the point, though it will be realised there were innumerable others.

Practical moulders might try for a few moments to place themselves in the position of the machinist, who is expected to turn out a good job from any particular type of casting delivered to him which had some difficulty in machining in somewhat the manner as before described. Now, however good this casting might be from the moulders' point of view, it very often presented many difficulties to the machinist due to not any defect in quality or design, but principally to the lack of co-ordinated effort between the moulder and the machinist.

Particularly was this the case where, due to trouble of porous bosses, etc., the moulder had resorted to curing these by the application of denseners or chills. Yet how often had this made the trouble of the machinist very much worse due to this chilling causing inability to properly machine the job? Moulders, patternmakers and draughtsmen, however highly trained in the general knowledge of their own particular products, had not the necessary knowledge of the inner detail of machine shop progress.

It was becoming essential, due to the many intricacies in design of the type of castings now made in general engineering work, that the view of the whole staff should be considered, having regard even after the strength, structure and design had been settled, as to how the job should be machined. It was also essential that this be settled before the mould was made, whereas how often was it found that this had to be determined after the job was cast?

It might be said that the draughtsmen or designers and patternmakers had a thorough knowledge of machine shop practice in some works and that these troubles did not occur.

If this were so, then the management was fortunate, yet, even so, it was well to remember how often two heads are better than one.

It was well to bear in mind that only a few years ago, in many circles, the draughtsmen and patternmakers had full control as to design and the making of a pattern for any particular job, and were considered to know all that was worth knowing about the moulding and making of good castings.

Yet it was surprising, in the same circles, when they made closer contact with the moulder as to best methods to adopt for the making of these castings, how the percentage of wasters was at once reduced and the quality of the castings in general improved.

An Outline of the Application of Machine Moulding to Jobbing Foundries

(Concluded from facing page.)

An actual example of better production is cited as follows:—

	Per day.
Job A.—Box 3 ft. by 2 ft. 6 in., jobbing moulder on piece ...	4
On machine; labourer and boy, piece	12
Job B.—Box 4 ft. 6 in. by 3 ft., jobbing moulder on piece ...	2
On machine; labourer and boy	10

One of these machines operated by boys will produce over 600 railway chairs per day.

The jarring machine is also very useful to jobbing moulding to eliminate hand ramming, leaving the pattern withdrawal and dressing to the moulders. Stripping-plate machines, although cheap in first cost are expensive to set up, therefore, their use for the average jobbing work is ruled out.

The best arrangement of a machine for jobbing moulding is a Jolt ram turn-over machine, in conjunction with a Sandslinger—the former making the drags and the latter the tops. One foundry has two of these machines operated by two labourers, which feeds 13 moulders, producing 40 boxes, 6 ft. by 6 ft., per day. Apart from quicker production, the moulding machine has many other factors which render it attractive to the jobbing moulder, some of which are as follows:—Less crane work, more output per given floor space, cleaner castings and more regular output.

The biggest effort in the introduction of moulding machines is to overcome the prejudice against the first machine installed. After this has been overcome the value will be realised and other machines will follow automatically.

It will be found that the patterns that require one casting only to be made from them can be handled expeditiously by the machine, helped by good patternmaking, willing moulders and an open-minded foreman.

Institution of Civil Engineers

The first number of the journal of the Institution of Civil Engineers, which is taking the place of the usual "Minutes of Proceedings," was published last week, and will appear more frequently. While maintaining continuity with previous proceedings, the journal will enable the early publication of Papers and the wide dissemination of the reports of the Research Committee and its Sub-Committees, which is one of the Institution's important activities. Further numbers will appear in December, January, February, March, April, June and October, respectively, making a total of eight during the year, of which six will appear during the session and two in the recess.

Leaves from a Foundryman's Notebook

III.—"IMPROVED DESIGN"?

By "RECORDER"

It is no uncommon experience for the foundryman, after having evolved a cheap and efficient method of producing any given casting, to be called upon by the engineering department to make subsequent batches to an "improved design." Often this phrase is a nightmare to the foundryman because it invariably means that the design is improved from a mechanical or engineering point of view to the detriment of its foundry possibilities. Many such examples could be called to mind in which this improvement has taken place to the entire satisfaction of the designer and engineer, but at a considerable cost to the foundry in time and material before a successful technique suitable to the changed conditions was evolved. Apparently one of the favourite "improvements" of recent years has been the incorporation of several rather simple components into one of a very complex form, which ideal, from the engineer's point of view, is a source of anxiety for the foundryman.

Another improvement is the substitution of roller or ball bearings for plain ones of bronze, and the following example is of a design which was a very straightforward job when plain bearings were used, but on "improvement" became much more difficult, owing to restricted outlets for the core.

Fig. 1 shows a half-sectional elevation of a drum for a haulage engine with plain bearings, the other half being a section of the mould after assembly, showing the cores in position. Fig. 2 is a similar section of the improved drum and its mould. To appreciate the difficulties encountered in the improved design a *résumé* of the moulding operations for both types is given.

Joints are taken in the mould in each case at A and B. The bottom is first rammed up on a joint board supplied with the pattern. On turning over, the middle is placed in position and bars C placed through holes in the side of the box; these carry further bars D placed on them at right-angles, which, together with C, carry the stays for holding up the middle portion of the mould. The top flange which in the smaller sizes is made of aluminium, is now placed in position and the top box rammed up. The top holes F, of which there are six, are marked on the pattern, no prints for this core being required, but in the top a ¼-in. vent is made at the centre of each hole. The mould is made of dry sand and the ropeway core G is built in before stoving.

The lightening core is made of a shell of sea-sand filled with fine ashes and bound with wires, the vents being brought up through the pods F. After drying, the mould can be assembled by placing the middle on the bottom and then placing the lightening core in on studs H. The centre core being inserted, the top is now tried on, care being taken to see that the vents from the cores match those in the mould. It has been found best to keep the core ⅛ in. shallow and build up a ring of loam around the vent to be pressed tight by the top to avoid metal entering the vent and causing the job to "blow." Although the moulding of the improved design was somewhat similar, a different method of coring had to be adopted because of the enlarged bore increasing the diameter of the boss so as to restrict the size of the top holes, which in this particular instance blocked-out the holes entirely.

The bottom side is required solid to keep dust, etc., from working through on to the internal gear ring fastened at I. As holes on the top were out of the question, prints had to be placed in the bottom; these were for ⅝-in. holes which could subsequently be plugged. Incidentally, the ropeway core had to be shifted from the bottom to the top to allow of the lightening core being placed in position in the prints and there stopped-in—to avoid metal entering the vents—before the middle was placed on.

The six ⅝-in. prints were made in one piece with the body of the core, and a ¼-in. dia. metal tube was placed in the centre of each down to the ashes in the interior of the core J. The centre core had to be inserted in two portions, the first before the lightening core and the

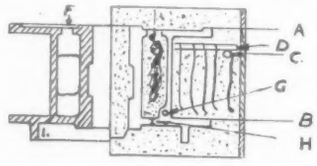

FIG 1

second after, because of the diameter K being more than L. The lightening core had to be secured against "lift," which was accomplished by two flat-headed nails as M placed over each pod. This "improvement" gave greater risks of waster castings, and cost more to produce in the smaller sizes, which were often required in batches of fifties. In the larger sizes the ball-bearing alteration did not affect the top holes to any appreciable extent, and these were still moulded as previously.

A note as to the dowelling of the various parts of these patterns may not be out of place.

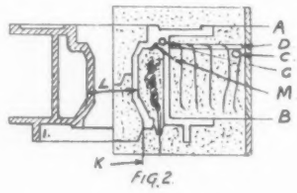

FIG. 2

This job is one where the disadvantages of the ordinary plug and socket standard-type dowel show up, especially when the flange may be as much as 5 or 6 ft. in diameter. Not always apparent in the patternshop, a visit to the foundry shows that difficulty can be experienced in locating the various portions of the pattern. A better method of locating is illustrated in sketch Fig. 3. This shows a piece of hard wood, or preferably aluminium, about ½ in. thick and approximately 5½ in. dia., with a considerable degree of taper on it as D, with a flat on one

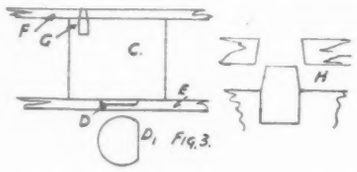

FIG. 3.

side D, for correct location. This is secured to the body C and fits in a recess in bottom E, which easily registers.

With standard-type dowels it is rather difficult to locate the top portion F on the middle C, because of the impossibility of seeing part C. Therefore, much time is expended in trying the top in various positions before it registers. A simple home-made dowel obviates all this bother. Two hard-wood joints of different character, but about 2 in. to 2½ in. dia. with considerable taper, are let in the top of the middle C. Corresponding holes are cut in the top F, and it becomes an easy job to locate these holes over the pins and let it drop in position. These are illustrated at G with an enlarged view at H.

Slush Pump Piston Cores Produced by Centrifugal Casting Process

(*Concluded from page* 379.)

by the time the pin has reached the temperature of the iron the metal has already set. Very few pins have burned in since this metal has been in use, and if the pins are not stripped too hot leave a very smooth hole.

The analysis of the core pins now in use is as follows:—T.C., 3.20; Si, 1.50; Ni, 32.00 to 36.00; Cr, 2.50, and Mn, 0.80 per cent. The use of metal core pins developed another source of trouble. After one or two castings the pins gave off a gas. This was traced to an oxide film on the pin. Sand-blasting after each heat remedied that trouble. The pins are cleaned while still fairly hot and dipped in the same wash that is used on the face of the moulds. Each pin can be used approximately twenty times before it loses its shape and has to be discarded.

Castings Produced

At the present time the foundry is producing from 110 to 130 cores per day, five days a week, with very little trouble. The scrap loss is very low. The centrifugally-cast casting has a very smooth outside surface and can be cast nearly to size, only ⅛ in. being allowed for finish. The same casting poured in stationary moulds is not as smooth, corners are not as sharp, show a coarser grain structure and on machining numerous bubbles will be uncovered on the upper side. Although no physical comparisons have been made between castings made in sand and castings now produced centrifugally, field tests have shown the superiority of the centrifugal casting. In deep-well drilling, where the old type core failed, the castings now produced are successful.

The Leipzig Spring Fair, 1936

The great Engineering and Building Fair which is to be held from March 1 to 9 next, concurrent and in conjunction with the Leipzig Spring Fair, is likely this year to have a significance and scope far greater than the engineering fairs of recent years could lay claim. For the year 1936 will be dominated by the world's greatest sporting event, XI Olympiad, which is sure to attract a large concourse of visitors from all countries first to the IV Olympic Winter Sport Competitions at Garmisch-Partenkirch, then to Berlin and finally to the whole of Germany. The number of exhibitors who have booked entries in advance for participation in the Fair is best illustrated by the fact that six months before the beginning of the Fair the exhibition area of several of the 18 commodious halls available for the purpose had been rented to the last square foot. A brisk demand for space is being recorded on the part of non-German manufacturers, and it is reported that numerous requests for exhibition space are being received by the management of the Leipzig Fair from manufacturers in other countries, who intend to exhibit their special machines in Leipzig. In their booking of entries for exhibition the Leipzig Fairs Board have laid particular stress on ensuring the participation of manufacturers who produce, above all, new machines, new apparatus and new tools. The display of exhibits will comprise practically everything of interest to the processing industry, ranging from the mammoth press to the very latest engineering material. The General Samples Fair will of course, as usual, contain full ranges of all classes of manufactured goods, and the Advertising Fair promises to be fully representative.

Die Casting*

By A. H. MUNDEY

Die casting is generally understood in our own country as that method of production by pouring or by forcing metal into highly finished moulds or dies, the result being a casting true to dimension and form, with holes and inserts as may be required, and frequently with internal and external screw threads complete, so that apart from a small amount of trimming and also polishing and plating the casting is ready for service or for assembling into machine parts, without subsequent machining operations.

In the United States the term die casting is reserved for that process which we usually describe as pressure die casting, whilst the method known to us as gravity die casting—that is by pouring from a ladle or crucible into the die, depending upon the head and runner for filling the mould completely—is variously spoken of as permanent mould casting, single purpose and multiple purpose mould casting.

In 1923-24, Anderson and Boyd classified the methods of casting then in use. Mortimer in 1926 adopted this, and Cartland and the author expanded this in a lecture to this Institute in 1929. Now, as at that time it is proposed to divide the art into two main divisions—gravity die casting and pressure die casting.

It is quite impossible to state when castings in metal were first produced, and, interesting as this subject may be, it is out of place to attempt researches in this direction, but it is permissible to point out that bronze spear heads and axe heads were produced by casting in long-life moulds carved out of stone or made in baked clay, by prehistoric craftsmen of several thousands of years ago. It is thus evident that the desire to avoid the destruction of the beautifully finished work of the moulder after each cast was very strong in the minds of the ancient foundryman.

Coming to comparatively recent times the application of die casting started either with the type caster or the bullet caster, the latter being developed during the American Civil War.

Type Casting

It is perhaps hardly realised that at the present time the greatest users of die castings and in fact the largest and most numerous die casters are the printers. Every type is die cast. In the old days type was die cast by pouring molten metal into a three-part mould held in the hand, or it was gravity die cast; now it is all pressure die cast. Founders' type, or as it is sometimes called case type, is cast in special machines, the metal being injected by a plunger pump into the mould, the character being formed by the matrix.

Composing machines, such as the linotype and intertype, cast slugs or plates with a line of type faces cast along its edge. The monotype casts single letters. These machines are pressure-casting machines of marvellous accuracy. Every day and still more every night hundreds of tons of metal are cast into stereo-plates for the production of newspapers, the moulds being of a papier mache material called flong, an example of gravity die casting of outstanding interest and importance.

The accuracy and high finish of the die-cast type is such a commonplace of life that it is hardly appreciated. [Here the author invited members to inspect a few specimens.] It must be remembered that these types are not hand finished in any way whatever.

Slush Castings

Probably the simplest and best known castings produced in permanent two-part moulds is the toy soldier; this is not only a die casting, but it embodies another feature of considerably economic importance, it is a hollow casting produced without "coring." The metal is poured into the mould, allowed to cool sufficiently to form a solidified lining to the form of the interior of the mould whilst the centre is still fluid, the mould is quickly inverted, the still fluid metal poured out, and the mould is now opened and the hollow casting ejected. Small statuettes and art castings are produced, and the process is called "slush casting."

The Corthias Process

Another process which has some application in art work is the Corthias method, used for shallow casting. A permanent and well finished mould is prepared and provided with a core corresponding to the form of the interior of the vessel to be cast. A measured quantity of metal is poured into the mould, and immediately the core is pressed by mechanical means into the molten mass. Centrifugal casting is so well understood by the present day foundryman that any description would be superfluous. But it is successfully applied to the production of die castings, particularly die-cast bearing-liners, but the utility of centrifugal casting is not confined to cylindrical or even to symmetrical castings.

Gravity and Pressure Die Castings

Gravity die castings are not as a general rule so highly finished, as to surface, nor are they so accurate and fine in dimension as pressure die castings; the reason is obvious, the weight of the fluid head and gate is the only pressure applied.

The metallurgical structure of a die casting is generally superior to that of a sand or loam mould casting, and it is claimed that a gravity die casting is in turn superior as to structure and solidity to a pressure casting. This is hotly disputed by the modern pressure die casters, who claim with well established reason that in the cast of high pressures now employed a degree of soundness and density is obtained which cannot be reached by any other method. It is, however, held that when a well regulated thermal balance between the mould and the fluid metal is maintained the metal freezes layer by layer, each succeeding portion feeding that below, until the gate is reached which should solidify last. The core is removed as quickly as possible to avoid setting up strains due to contraction stresses. In fact, one of the most important factors in the technique of the operators is the removal of cores and the rapid stripping and dismantling of the mould.

The displacement of the air contained in the mould is in gravity die casting a relatively simple operation and only a limited provision for venting is necessary, but that depends upon the form of the casting to be produced and naturally that of the die. Another factor sometimes overlooked in die casting as in general foundry work is the dissolved or occluded gases, which are largely released as the metal approaches the solidifying point; provision must be made for the elimination of the gases, or the collection of them in the heads and risers, or unsound castings will be produced. Yet another cause of disappointment is the formation of cavities which on close inspection are found to differ in form from air or gas holes. These are shrinkage cavities. They are seen under a magnifying glass to be angular in form, and are caused by the metal crystallising in its natural way whilst solidifying. Meanwhile, the still fluid portion drains away, leaving small holes or spaces.

Gravity die casting is all important in industry, and as stated, the principle is very old. Present day practice entitles it to the greatest respect both for the amount of work produced in permanent moulds with gravity feeding only, but for the excellence of the product in design and material.

All the metals and alloys used in the industry can be and are regularly die-cast, although there are many designs placed before the producers which are so intricate, that the use of gravity methods would be courting failure.

Alloys Utilised Commercially

The number of articles now produced by gravity die casting is enormous. Bearings and liners are made in lead-base and tin-base metals, battery plates and grids—a very important and rather difficult job in lead-antimony alloy or in lead hardened with calcium and the alkali metals. Numberless small jobs are made in zinc-base alloy, but pressure casting is much to be preferred in this type of work. Aluminium and other light alloys, both gravity and pressure casting receive favour according to circumstances. A notable job for gravity casting in aluminium alloy is the piston for automobile engines. The ease and rapidity of casting depends greatly on the variation in design, thus some pistons are so contrived that in order to withdraw the cores, from small pockets, a central three or four part core is required, and this is withdrawn in sections. Portions have to rotate through a part of a circle before they are free. This sort of thing emphasises the desirability of a conference between the designer of the casting and the die designer; much time, energy and money are wasted by neglect of this simple and obvious course.

Aluminium Gear Boxes

A splendid example of high efficiency in design and organisation is given in the production of an aluminium gear box by the engineers of Messrs. Leyland Motors. The finished weight of the casting was 52 lbs. The alloy was copper 7½ per cent., silicon 3½ per cent., the remainder being aluminium. The contraction allowance was 0.008 per in. The die weighed 1 ton, and was made of cast iron in two main sections, but contained twenty-eight working parts. The temperature of pouring was 750 deg. C., and the mould heated to 400 deg. C.

A comparison of time of production was kindly furnished:—For sand castings, 3¾ hrs. per box; die casting, 12 mins.

Four men were engaged in the operation, and 2,000 castings had been made up to the time of report without replacement of mould parts. There was a saving of 10 lbs. of metal in the die casting over the sand casting.

Aluminium Bronze

For the casting in aluminium bronze, gravity die casting is employed almost exclusively, and most successfully. [Examples were then shown of castings thus produced.] Pressure casting can be employed, but having regard to the wear and tear upon the die, it cannot be regarded as an economic success. High-tensile brass, is gravity die cast, with success, as is also aluminium brass. The 60 copper, 40 zinc, brass is cast with success by either gravity or pressure process, but the methods and technique used in the latter is of the greatest interest.

Nickel Alloys and the Holley Process

Nickel alloys, that is so-called nickel-silver, and also nickel additions with or without iron and manganese to the aluminium bronzes, are capable of gravity die casting. They can be pressure die cast also, but the effect on the dies is so severe that the proposition is, though full of interest, not an economic one. Finally in reviewing the possibilities of gravity die casting, there is the Holley process, successful means of casting in iron. The walls of the dies are relatively thin, and the exterior is furnished with vanes for air cooling similar to an air-cooled engine. The interior parts are carefully coated with a very thin wash by spraying, leaving a refractory lining. This is further protected by a coating of

* Based on a Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. J. Jackson presiding.

XUM

soot produced by an acetelyne flame. The moulds are arranged upon a rotating table or a moving platform, and brought under the ladle. The moulds are stripped very rapidly. This method, together with very carefully selected iron for the charge, results in castings which are dense and strong, yet capable of machining, and are not chilled as would have been expected in early days from an iron charge cast in a chill or metal mould.

Machines

Pressure die casting. This is so closely associated with the methods employed that it will be interesting to refer to the machines and their products in direct relationship. The author repeated the analogy of the teapot to the early combination of metal pot and pressure machine. Imagine a metal pot, shaped essentially like a teapot, the lid is removed and replaced by a plunger, the die is fastened to the spout, molten metal is maintained in the pot or vessel. A sharp blow on a wooden knob at the top of the plunger ejects a charge of molten metal from the spout into the die. An apparatus patented in 1872 was in actual operation. Throughout the past sixty years and particularly during the last fifteen years, the machines and apparatus have been elaborated and improved, yet throughout in the case of plunger machines the same general principle has obtained. Let it not be thought that because the process is simple in principle that it is an easy operation, for that is not the case, the illustrations will serve to indicate something of the progress which has taken place in recent times.

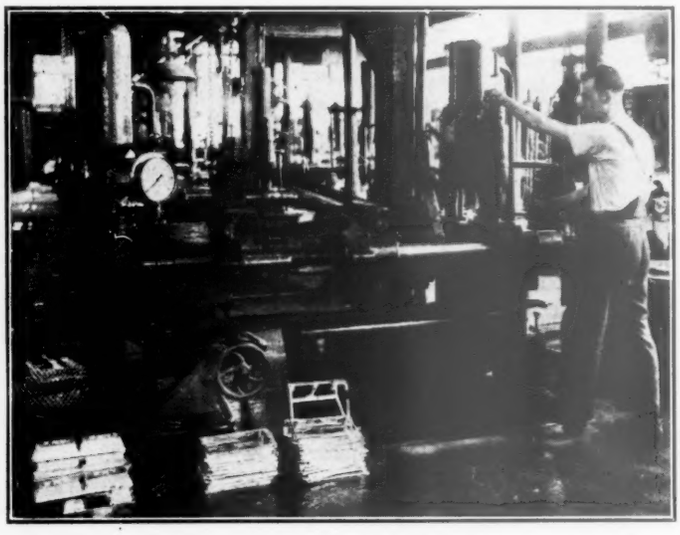

FIG. 1.—MEDIUM HYDRAULIC MACHINE FOR DIE CASTING—ONE OPERATOR.

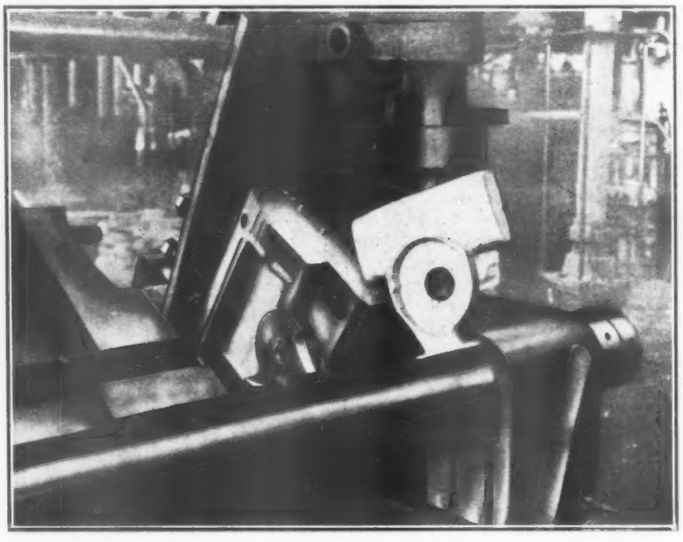

FIG. 2.—LARGE MACHINE. CLOSE-UP OF DIE IN PLACE WITH CASTING JUST EJECTED.

The Doehler Machine

The Doehler hand-operated machine which was introduced nearly thirty years ago is still in use, and a more excellent apparatus for studying the fundamental principles of pressure die casting can hardly be imagined. The plunger is operated by a long arm connected by a bell-crank lever to the plunger, and moves in the cylinder which terminates in the nozzle, the axis of which is at right angles to that of the plunger, the cylinder being either a part of or immersed in the well containing the molten metal. The die is held on a hinged plate, the two parts being held together by a toggle joint. The cylinder is filled by withdrawing the plunger a stated distance sufficient to uncover a port. The die is locked down so that the aperture or sprue is in close contact with the nozzle. The forward motion of the piston closes the port and forces the contained molten metal through the nozzle into the die. The die plate is unfastened, swung away on its hinge and the die opened by the toggle, the cores if present are withdrawn, the casting ejected by ejection pins, and the whole cycle of operations repeated.

It is not the mechanical operations, although they are of the utmost importance, to which special attention is directed. It is of special interest to watch the man at work operating the lever. The experienced operator varies the speed and character of the pull according to the size and form of the casting. A short sharp pull is sometimes needed, whilst a long pull with a decided "follow-through" is advisable in another case. The success of these variations is quite marked. The lesson to be learned is that a simple mechanical operation cannot copy faithfully the human skill. But when an air-operated system is interposed the resilience of the compressed air accomplishes the slightly prolonged action.

The positive action of the toggle is also a good lesson for the designer of the more modern and high-powered machine, for in these cases the tendency is to force the dies apart, due to the inrush of metal at high pressure, and this has to be counteracted by powerful devices, out of all proportion to the apparent needs of the operation.

Out of this simple machine has evolved mechanically-operated casting apparatus which is turning out thousands of small castings daily, in various establishments. The temperature, consistency, and general character of the lower melting point alloys, that is, zinc base, lead base and tin base metals, can be studied and standardised.

The difficulty in managing the plunger and cylinder as devised in the Doehler machine and others of this type at the temperature necessary for aluminium, and the action of molten aluminium on a well-fitting plunger and pump cylinder which is constantly submerged in the metal, brought about the use of air pressure to squirt the fluid metal into the die.

Vessels made on the principle of the chemists' wash bottle or the ladies' scent-spray were devised. These had obvious disadvantages which were overcome gradually by arranging that the air from high-pressure cylinders should be cunningly admitted into an annular space in the upper part of the metal container, the pressure on the surface of the alloy being suddenly raised and the metal squirted out of the nozzle communicating with the bottom of the vessel without spraying, but in a full stream or jet. Pressures as high as 600 lbs. per sq. in. are used with success.

Goose-Neck Machine

The principle of the U-shaped tube was also introduced, care being taken that the metal should not pass beyond the lower part of bend; in some cases a fluid plunger of molten lead was introduced. From this, it would appear, was evolved the goose-neck machine, one of the most favoured type of machines in general use.

The goose-neck machine is so designed that after each casting operation the nozzle of the metal pot shall dip into a well of metal and take up a fresh charge, which is in turn forced into the die immediately the nozzle has been brought into intimate contact with the sprue or entry in the die. The die is held together with great firmness and the contact of the nozzle with the sprue passage is adjusted with care, any looseness or bad fitting in these positions give rise to bad castings, thick fins, splashing, etc. The operations are automatic and the sequence of the stages is carefully guarded and controlled.

The ejection of the sprue or tail piece has been a problem, and so a split sprue arrangement which facilitates the ejection of the casting has been devised. The cover die remains stationary over the melting pot, and the ejector die is pulled back through a camshaft operated by a worm and worm wheel. Cores are removed automatically.

Mr. Marc Stern describes in his book a further modification; the ejector die is stationary and the cover die is movable. An air cylinder operates a plunger, which forces the metal through the centre of the cover die. This unit and the furnace are supported up a saddle, and with it are movable. This arrangement protects the die from excessive heat by radiation. These machines are adapted for use with all the alloys up to and including the aluminium alloys, that is, those operating up to temperatures not exceeding 700 deg. C.; actually the working temperature is usually well below 650 deg. C.

The introduction of the use of the plunger type of machine so arranged that it shall not be constantly immersed in the molten metal and with a different mechanism owes much to Josef Polak and several of his contemporaries.

Polak Machine

The Polak type of machine uses hydraulic power for operating a plunger acting directly upon the metal, as illustrated in Figs. 1-3. As

hydraulic power does not furnish that resilience which is so desirable, the inventors added high-pressure air to the hydraulic fluid, thus a pressure of upwards of 3 tons per sq. in. can be obtained, and at the same time the plunger is actuated in a fashion which is greatly augmented. Copy of the human pull on a sensitive lever.

The great advantages which accrue to these modern machines are immense power and pressure, producing sound, dense castings, great stability, capacity for production of very large castings of high finish.

The valve mechanism and intensifiers are very complex and ingenious. A clever device for the removal of the excess of the metal after the casting operation is a special feature, and beyond this the machine is capable of and designed for the production of die castings in 60:40 brass at a temperature of about 950 deg. C. to 970 deg. C.

Modifications of the type of machine which has been illustrated consist chiefly of that known as the "parting line device." The features were described in an article* by Dr. Ladislav Jenicick. The machine is operated in such a manner that the metal container is a part of the die, a measured portion of the metal in a semi-solid or plastic condition is introduced, and the plunger injects it into the form of the die, which when parted allows the casting with the gate and surplus of metal attached to be removed as a whole.

Another system* also described and illustrated in the same article is the Buhler machine, which operates in the horizontal direction. In this case the die parts and leaves the casting with gate and surplus attached.

The Pack machine working in a vertical plane is yet another example of the same character of making the die a part of the machine, or rather it embodies the metal container as a part of the die, and delivers the casting gate and surplus attached.

Yet another machine by Ekart has the plunger working vertically but from underneath. The metal is temporarily contained in a thin asbestos cup. This is also a parting line machine.

It is not possible to describe or even to refer to every machine which has been invented during the past few years. The engineers have been very busy in devising methods of overcoming the difficulties which have been encountered and also in avoiding the special features of machines of competitors.

Metals and Alloys

The alloys employed in the industry of die casting are of necessity very numerous. It is fair to say that practically the whole family of white metals, that is, those combinations of lead, tin and antimony with or without small amounts of copper, and even cadmium and bismuth can be and are employed to a greater or less extent. Thus there are the Printers' metals, of which the following are representative:—

	Sn. Per cent.	Sb. Per cent.	Pb.	Cu.
Founder's type	12 to 25	20 to 30	Remainder	1 per cent. (max.)
Linotype ..	3 to 4	10 to 12	,,	,,
Intertype ..	3 to 4	10 to 12	,,	,,
Monotype ..	5 to 10	15 to 19	,,	,,
Stereotype ..	5 to 10	14 to 17	,,	,,

Lead Base Alloys for Bearings

These vary from 5 to 10 per cent. tin, 12 to 15 per cent. antimony and the remainder lead. Sometimes copper and other metals are added for special features, and include many important brands, such as Magnolia, Eyre, Tandem, Atlas, etc. Lead-base alloys, consisting of lead hardened by the addition of calcium, barium, sodium may be die cast. Battery plates and fittings for accumulators are of lead hardened by antimony of from 5 to 10 per cent., and also lead hardened by the alkaline earths. Regulus alloys of special purity for chemical engineering are also die cast.

Tin-base alloys as used for anti-friction metals are all capable of being die cast. These range from 93 per cent. tin down to 5 per cent. tin. The high grades are lead-free, and special additions of the rare metals are added to give special resistance to fatigue stresses; all of these are die cast if required.

Special tin-antimony alloys are used for certain parts of gas meters, they contain upwards of 70 per cent. of tin; they resist the action of hydrocarbon gases to a remarkable extent. They are capable of being die cast with remarkable accuracy. All the pewters and so-called Brittania metals lend themselves to die casting.

Zinc-Base Alloys

This is probably the most important family of die-casting alloys, a distinction which it may be said to share with the aluminium alloys. The reports in a Paper to the Institute of Metals,

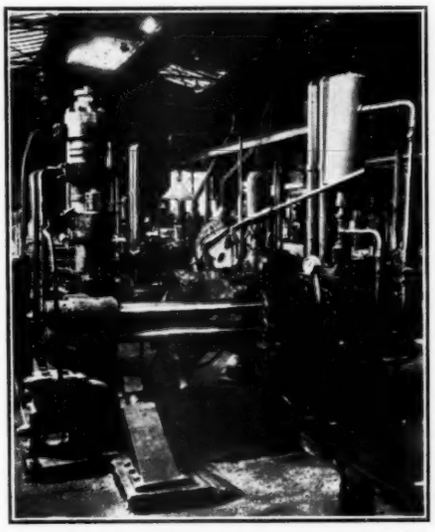

Fig. 3.—Large Hydraulic Die-Casting Machine with Air Reinforcement capable of exerting pressure of 350 tons.

Vol. XL, No. 2, by Russell, Goodrich, Cross and Allen, gave numerous figures which were the basis of those given to this Institute in 1929. The alloys in this series are divided into two distinct groups:—(1) the older-fashioned composition, in which zinc is hardened by the addition of tin and copper, with a small proportion of aluminium, and (2) the alloy which is in most general use at the present time, zinc hardened by aluminium and copper, with a small addition of magnesium.

Under (1) the alloy consisted of tin 7 to 10 per cent.; copper, 4 to 7 per cent. and zinc balance, while about 0.2 to 0.5 per cent. of aluminium is added for a double purpose—as a deoxidiser and to prevent the tendency to galvanise the dies and machine parts into which it comes into contact at a high temperature. This alloy gives fine finish, great accuracy as to dimension, but it is accused of being liable to age-hardening and cracking, with subsequent internal corrosion and distortion. Impurities are apt to produce these effects. The strength of these alloys is found to be about 9 tons per sq. in., as a practical maximum. They are not ductile.

(2) The second type of zinc-base alloy contains about 4 per cent. aluminium, 3 per cent. copper, and about 0.1 per cent. magnesium, with occasionally small traces of rarer elements, the remainder being zinc. It is essential that the constituent metals shall be of the highest purity possible. Tensile tests give 18 to 20 tons per sq. in., with a reasonable amount of ductility. This is shown more definitely in a twist or torsion test than by a marked elongation in a tensile test.

Aluminium Alloys

For gravity die casting, aluminium with 8 to 12 per cent. of copper is used for pistons for internal combustion engines. Manganese up to 1 per cent. is sometimes added, but it decreases the thermal conductivity.

Y alloy 4, which consists of: Magnesium, 1.2 to 1.7; nickel, 1.8 to 2.3; copper, 3.5 to 4.5 per cent., and aluminium remainder, is an excellent material, capable of heat treatment for the improvement of its physical properties. For pressure die castings, the alloy of 11 to 13 per cent. silicon, remainder aluminium, is undoubtedly first favourite.

There are many special alloys which have high properties, and are highly recommended in view of their strength ductility and resistance to corrosion. The most recent is that developed by Mr. A. J. Murphy, of Messrs. Stone & Company, called Ceralumin. [Some specimens were then exhibited.]

Aluminium Bronze

Gravity die castings in aluminium bronze are of the greatest importance. They are as strong as a medium grade steel, have a beautiful skin and colour, whilst the machined surface is like gold. They resist corrosion to a marked degree, and are very reliable. A whole section of the industry is devoted to the production of this work, the value of which cannot be over estimated.

Brass Die Castings

Both gravity and pressure work are successfully carried out in brasses of approximately copper 60 per cent., zinc 40 per cent. It is this alloy which is the basis of brass pressure die castings. Here a feature of the work is the production of the castings at a temperature between the solidus and liquidus, the consistency of the metal being that of melting snow, and the production of the casting under high pressure. Excellent results are obtained, and the process which is past the experimental stage is full of promising possibilities. Tensile strengths of over 25 tons to the sq. in. are obtained, and this would no doubt be increased, but there is one handicap. The high stresses upon the surface of the die, coupled with the high temperature and the speed of the metal travelling over the die face, produces a crazy pattern of hair-like lines upon it; these gradually deepen, thus in most cases the die-life is short. It is possible that this may be overcome in time, and researches into various kinds of alloy steels and heat treatments are going forward. The problem is a difficult one, but it is hoped that it is not an insoluble one. It has a distinct bearing upon the economic position of pressure die casting in the alloys of the higher class.

Die Design

Die design is the most important factor in the whole industry. The engineer must see in imagination the finished casting, then reverse the whole conception, as in the case of general foundry practice, but with this cardinal difference, the material of his mould and in almost all cases his cores is of hard steel, difficult and expensive to fashion into shape. The mould or die must fit together with extreme accuracy, admit of being opened to deliver the casting without distortion or damage, and provide for crystalline and thermal contraction and permit the expulsion of air contained in the die and of gases dissolved or occluded in the molten metal. There are many more factors, but these serve to show the scope of the problem set the die designer. The dies are water cooled by water passing through closely placed channels.

* "Metal Industry."

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The material of the die is of great importance. As a rule the base is of good cast iron, the body of the die, both upper and lower parts, of high-grade steel forging, frequently of chrome-vanadium steel. After forging, the steel must be normalised, and after a certain amount of machining a further annealing is given. The cores and special working parts are of high-tungsten steel. The dies are, after finishing and testing, generally heat-treated and hardened and tempered under strict pyrometric control.

The die making is carried out by craftsmen—engineer-mechanics who are artists. The machining and fitting operations are of the highest order; in fact it would be difficult to describe the excellence of both design and workmanship without superlatives. When a die is nearing completion wax or plaster casts are taken, and after necessary adjustments it is tested by placing in the machine for trial casting before the hardening and tempering operations.

In the production of aluminium bronze and of brass castings in the gravity process, aluminium-bronze dies are sometimes used and sand or loam cores for intricate interiors. It is suggested that an inspection of the specimens [exhibited] indicate to some extent the scope of the present-day application of die castings. The references already made should reinforce this mental picture. As to its future, who knows? One thing is certain; die casting is not a process which sometimes provokes a comment on mass-production methods as something unworthy, cheap and nasty. It has not destroyed any industry or trade, but has created and fostered its own and other markets. The fact that pressure casting cannot be considered as a means of production unless numbers of, say, 10,000 can be ordered, makes it clear that there is no real competition with general foundry work of the best grade. This apart from the limitation of size.

It is useless to ask for a quotation for die castings at a price per pound, for the more intricate and valuable products are often too light to be valued in this fashion. Yet, in considering very large numbers it is a very inexpensive method of production and the only way that the articles [exhibited] could possibly have been made. As a mass-production job die casting does not destroy the ingenuity or initiative of any of the operatives, but encourages skill and concentrated application. The finishing, polishing and plating of die casting constitute a section which involves much technical skill and which repays genuine study. It is fair to claim the whole industry of die casting as a valuable addition to the engineering and manufacturing world.

Vote of Thanks

Upon the motion of MR. J. HOGG, seconded by MR. A. PHILLIPS, a hearty vote of thanks was unanimously accorded to Mr. Mundey for his extremely instructive and interesting Paper.

DISCUSSION

MR. A. PHILLIPS (Manchester) mentioned that Mr. Mundey had not described the "Soag" machine. Did this machine compare favourably with the "Polak" machine in regard to the "push through?" He would also like to be informed as to what method Mr. Mundey adopted for heating up dies, as this was of great importance to the steels.

MR. MUNDEY replied that he was not very familiar with the "Soag" machine, but he did not know that any machines other than the "Polak" were working hydraulically on the air principle. There was no reason why they should not; but there would have to be a re-designing of the valves, etc. He did not think there was any patent to prevent this being done.

MR. A. PHILLIPS said that the "Soag" machine functioned with air and water.

MR. MUNDEY replied that, in that case, the "Soag" machine should function in a similar manner to the "Polak." As a general rule, before work started in the morning the dies were heated up by means of gas jets, and extreme care was used by the casters in doing so. He had a great admiration for the casters, who worked very hard and tended their machines as though they were babies. The dies were heated for a few minutes, sometimes for as long as a quarter of an hour, and then a few castings were made. No water was run through until everything was ready. Then the water was turned on very carefully. All the dies were water-cooled, the die designer being very careful to keep his water channels well back so that the cooling was only done by conduction and absorption.

MR. A. PHILLIPS asked what annealing temperature was used in the production of dies made from forged chrome-vanadium steel.

MR. MUNDEY said for chrome-vanadium steel a temperature of something like 950 deg. C. was required. For the heat-treatment of the higher-grade steels 1,300 deg. C. was necessary, because they were very hard. The time depended upon the mass. Quarter of an hour would be sufficient for a small die casting, but a large one might required a prolonged period.

MR. A. SUTCLIFFE (Bolton) asked whether Mr. Mundey could cast gun-metal, because if he could then he knew of a firm who would at once dispense with the services of two moulders. He had brought a number of samples of gun-metal castings with him which were typical of about 4,000 now lying useless at the foundry simply because a correct copper alloy was not obtainable. He would be pleased to receive some information from Mr. Mundey with regard to a way out of the difficulty.

MR. MUNDEY said gun-metal was very difficult to die cast. He did not say that it could not be die cast, but he did not think it would be worth it. He had referred to the work of the craftsmen of ancient Greece and Rome in the production of gun-metal castings of axe and spear heads in permanent moulds. But these were simple castings. Gun-metal has a very short plastic range; that is, there is a very short gap between the solidus and liquidus. The early worker was able in the cases mentioned, working on an alloy very near the eutectic, to make good castings, but this is not easy if the casting be of complex design.

Mr. Moreland, who was present, had experimented with the making of die castings in gun-metal; perhaps he would say if it were a reasonable operation.

MR. MORELAND here stated that gun-metal is not an appropriate alloy for die castings as a commercial job.

MR. MUNDEY further remarked that when all was said and done die casters generally did not care to undertake jobs which were not paying propositions. There would be too many wasters in the case of gun-metal. The specimens exhibited by Mr. Sutcliffe had a zinc base.

MR. A. SUTCLIFFE replied that that was so. He had been informed that the casting could be made in gun-metal. He was pleased to learn from Mr. Mundey that that was not possible.

MR. MUNDEY said that castings could be made in 60/40 brass, commonly known as "Muntz" metal, which was practically the same as manganese bronze, except that the latter had a few small additions. Those small additions were somewhat of a nuisance for die casting. There was one small point he would like to bring out in connection with one of the exhibits produced by Mr. Sutcliffe, which was a zinc-base casting. It was broken. There was a great deal in the psychology of a user. If the user was driving his car out of the garage and just touched the handle of the door on the side of the garage so that it broke off, then, if it was made of brass, he would say, "What a nuisance; I must have given it a really good biff!" If when it was broken it showed up as white metal, he would say, "Well, that's rotten stuff," though it might have been equally as strong as brass. He would not blame himself as a driver; he would blame the handle.

MR. A. PHILLIPS asked why was a large sweeper casting, which had been described, made of 13 per cent. silicon-aluminium alloy.

MR. MUNDEY said it was the only alloy it would cast in. The idea was that if it was not possible to cast a casting of aluminium with 13 per cent. silicon alloy it was not possible to cast at all. It was the best alloy for casting aluminium alloy.

MR. SUTCLIFFE asked whether it was possible to die cast a pressure gauge for a boiler. He had to sand-cast hundreds of them each week. Was there any difficulty concerning contraction or cracking if cast in a die?

MR. MUNDEY said they would not contract or crack if made properly.

MR. E. SUTCLIFFE said he was machine moulding them in yellow brass, and not making them from zinc-base or aluminium alloys.

MR. MUNDEY said he did not like yellow brass for die casting. The difficulty was that brass die castings were cast at a temperature of 950 to 1,000 deg. C. At that temperature the metal rushed into the die, and set up stresses upon its face. The heat was conducted away by the mass of the die. This went on time after time until presently hair-like lines appeared on the face of the die very similar to crazy pavement pattern. These lines became deeper, and as a rule it was only possible to get about 1,000 castings from the die. This amount of production was not sufficient in the case of an expensive die. Therefore in a general way it was not a practical commercial proposition to make pressure castings in yellow brass. This is not a universal rule for as many as 15,000 castings had been produced, but they were of suitable form and thickness. Of course, it could be done in other cases if one was prepared to pay for it.

MR. A. PHILLIPS asked if any dressing was put on the face of the die.

MR. MUNDEY said that a little china clay was used, and sometimes a little graphite mixed with a white French chalk. It was not sprayed on, but put on very quickly by means of a rod. Sometimes they were smoked.

In further reply to Mr. Pendlebury, Mr. Mundey said that deep dies were sometimes sprayed. He was speaking of pressure casting. For gravity casting spraying was quite a different matter and was good.

The proceedings then concluded.

Catalogue Received

Continuous Core Stoves. The Foundry & Engineering Company (West Bromwich), Limited, Sandwell Road, West Bromwich, has prepared a special brochure to introduce the "Acme Junior" continuous core-baking oven. It is a three-stage plant carried out on a tray conveyor. The first stage rapidly heats up the cores from the hot products of the furnace; the second stage carries out the oxidation of the linseed oil by the admission of free air passed through a superheater and the third stage is that of accelerated cooling by driving air across the cores. Detailed attention has been given to the construction of the trays to allow of a maximum of elasticity as to size of cores admissible. A second feature is that the plant only occupies 8 ft. by 6 ft. 6 in. Claims are made for ease of control, low running costs, cleanliness and absence of all fumes. The booklet runs to six pages and carries a picture of the new plant. We advise our readers, especially the small and medium-sized concerns, to procure a copy of this publication.

Physical Tests for Cast Iron

By JOHN SHAW (Ex-Convenor of the Institute of British Foundrymen Test-Bar Committee)

It is common knowledge that a revision of the British Standards Institute specification 321/28 for grey cast iron is being considered. With the great advance in the physical properties of this material, such a step is overdue. In this connection certain tentative proposals put forward by the Technical Committee of the Institute of British Foundrymen are worthy of attention. They suggest that the present 321/28 remains as it stands, as regards breaking loads, but with some modification to the relative sectional thickness of the casting as now represented by the present test-bars. To meet the needs of the stronger irons, they suggest a new specification, retaining the S and M sizes of bars of 321, with possibly a modification of the L bar and the introduction of an intermediate bar of 1.6 in. As stated at Sheffield, the matter has proceeded so far that both tensile and transverse loads for the three bars S, M and L have been agreed on tentatively. This, in the writer's opinion, is premature until certain fundamental issues have been settled:—

A New or Modified Specification

(1) Is the proposed "High-Test" specification one that the engineer can specify for all grey-iron castings not now covered by other special specifications? In short, is it simply an advance on the loads of 321/28? If so, the maximum breaking load will be governed by a number of large castings, such as turbines, long bedplates, and the like, which with this low-carbon close-structure metal are liable to fracture under sudden impact or quick changes of temperature. It is now a fairly well-established fact that, with increasing tensile breaking load, the transverse load does not increase proportionately, whilst the impact values are very disappointing. The tensile is favoured by foundrymen because it is easier to obtain and is more consistent in its results, but it is no true guide as to the quality of these low-carbon cast irons. It depends on the closeness of the structure for its results rather than the quality and toughness of the iron. The irregularity often found in the relative transverse tests is largely due to the fact that these different physical properties are under test. The very closeness of the structure, although showing high tensile results, is against that minute "give-and-take" so necessary in some castings. This quality also affects the claim made that cast iron is more resistant to sudden impact when compared with comparative tests of other metals, due, in fact, to the "damping" effect of the graphite present. In short, the more one approaches steel conditions, the more need there is for steel-moulding methods and modified heat-treatment.

It has not hitherto been the practice of the British Standards Institute to issue a *general* specification qualified by the inclusion of numerous exceptions.

Functions of a Test-Bar

(2) What is the exact function of a test-bar? It was recently stated "that the test-bar, when tested, should show approximately the same strength as a specimen cut from the casting." How far does the present 321/28 fall into line with this statement? While the $\frac{3}{4}$-in. (S) bar may approximate to this dictum, many of the results on both the M and L bars are a long way from fulfilling the requirements. The 1.2-in. bar covers cross-sections up to $1\frac{3}{8}$ in. thick. One has only to compare the tons per square inch taken from bars 1.2 in. dia. and $1\frac{3}{8}$ in. cast from the same ladle to realise this. Numerous examples are given by Rother, Pearce and Harbach. Rother shows a loss of 14 per cent. between bars 1 in. and $1\frac{1}{2}$ in. dia. cast from the same ladle, with 18 per cent. on two similar bars cast from another mixture. Even in MacPherran's 80 per cent. steel alloy metal there is a difference of 12 per cent. between the results on a 1.2-in. and 2.2-in. dia. bars. This means, however sound the casting may be, if the main cross-sections are $1\frac{3}{8}$ in. thick, the engineer's safety margin of 6 to 1 is automatically reduced to 4 to 1, although his 1.2-in. bar may show the stipulated load. This anomaly was due to a compromise with firms who had built up data on the $1\frac{1}{4}$-in. dia. tensile bar, but more because many testing machines would not deal with the L bar. Whatever excuse there might be 16 years ago when trying out a new departure, no excuse can now be found for perpetuating the same error. Yet the old bogie, the capacity of the testing machine is still in evidence. One proposal is that the 2.2-in. bar should have a length of 15 times the diameter, similar to the 1.2-in. bar. This means a bar 39 in. long tested at 33-in. centres. It may interest the proposers to learn that a few years ago three reputable firms tried out this. Over 50 per cent. of all the bars, which were cast in vertical moulds, green sand, top poured, turned out defective. To ram up and cast on the flat introduces other difficulties. Whatever scoria or sand washes off, lodges somewhere on the upper half. The fine fins at the joint yield not only fine cracks on each side, but a different structure. A depression sink is also often found in this L bar on the top side, while the long span tends to reduce the transverse value. The economic side need not be stressed. Comparisons are often made with the 2-in. by 1-in. by 36-in. centres bar. It must, however, be remembered that in this case the joint is at the top and any defects are usually found there. To minimise this, the top side is always placed in compression when testing, but the defects in a round bar cast on the flat may be in any part above the joint. From the above statements one clear fact emerges, that is, *that in no case should the test-bar as cast be less in diameter or cross-section than the average cross-section of the casting it represents.*

Size of Test-Bar Related to the Casting

(3) According to Schwarz, and Vath, even the modification of the limit of the sectional areas would not meet the case. They found that the test-bar should be twice the diameter of the mean cross-section of the casting it represented, if a similar structure was required. In this country Dr. Swift carried out somewhat similar tests with approximately the same results. Several reputable firms supplied him with sets of various size test-bars, together with plates of the same thickness cast from the same metal. Bars were cut from the plates, turned to the same diameter as the round bars, tested and compared with the result as stated above.*

While these results can be accepted without question under the conditions and compositions used, how far the conclusions could form the basis for fixing the relation of test-bar diameter to section of casting as embodied in a National Specification is open to doubt. There are few metallurgists who would mix metal to obtain maximum tensile strength in a 4-in. round and not expect chilled edges on a casting 2 in. thick. The very fact that one firm supplied bars and plates that balanced themselves at every diameter and thickness (Fig. 7)* is proof that that under some conditions and mixture satisfactory comparative results are obtained.

The present method of cutting test-bars from castings and then turning the cut-out piece to some diameter below the size necessary to obtain the grip ends is no fair test of the strength of that casting. Thos. D. West years ago showed that a cold dry-sand mould had a diminishing densening effect for at least 1 in. inward. More recently this has been confirmed by several investigators. If a bar was cut from the edge of a 5-in. dia. bar and another from the centre, the latter was between from 1.5 to 3 tons per sq. in. lower, according to composition. If this be granted and applied to a test-bar cut from a plate, it is evident that in turning this square bar to a given diameter all the stronger material is being cut away, leaving only two small arcs, with the remainder consisting of the softer core. In the case of a round bar turned to the same diameter, the whole of the circumference consists of the strong iron only found in the arcs of the bar cut from the plate or casting.

Composition, melting practice, type of material charged, if the metal is innoculated and by what, has a great influence on the variations found between the bars cut from the edge and centre of a casting. McRae Smith* gave a list of analyses and tests cut from the centre and edge of 5-in. dia. bars. If one takes the bars cast from pig and scrap alone, the difference between the bar from the edge and centre is 3.1 tons per sq. in., while those with 40 to 50 per cent. steel scrap only average 1.3 tons per sq. in. different. Yet the T.C. + Si in the first case was 4.99 against 4.94 per cent. in the latter. With the medium-steel scrap in the charge, an intermediate figure was obtained. While there is no doubt that steel additions, when properly melted, do tend to equalise the structure, other factors enter with metals giving higher results. MacPherran, with 80 per cent. steel and a finished T.C. of 2.55 and Si 2.23 per cent., yielded 24.55 tons per sq. in. on the 1.2 bar, 21.65 tons per sq. in. on the 2.2-in. bar, but on the 4-in. bar, cast from the same ladle, a bar cut from the edge gave 23.25 tons, while the one cut from the centre only yielded 17.85 tons, a drop of 23 per cent., nearly as bad as the all-scrap and pig-mixture with its 26 per cent. drop.

Inoculation by Ferro Silicon

This result raises the whole question of the effect of deoxidation and inoculation. In a Paper last year by Lemoine, the author states: "In cupola melting of steel scrap, silicon added when the liquid iron comes from the spout, seems to be more active in promoting graphitisation during rapid cooling than when incorporated in the charge. Such an action, which is not accompanied, at least in the low-carbon irons, with graphitisation of the pearlite in the internal part of the thick sections, is interesting, since it tends towards uniformity of structure and strength throughout the different parts of an intricate casting." MacPherran in the discussion confirmed it. The writer called attention to this difference some years ago, but put the difference down to the time and temperature effect. If high-silicon pig or alloy is melted with the charge, the time for the growth of the graphite nuclei is increased and that under favourable conditions. If charged down the spout the result is a finer graphite as proved by both photomicrographs and tests. To try to throw some light on both items 2 and 3, a series of test-bars, plates and special plates with enlarged ends were made. The enlarged ends were densened so as to equalise the structure with the plate portion. These were cast from metal run into castings about 10 tons weight. The castings were sound and machined well. One set of bars consisted of two bars 1.2 in. dia. whilst additionally a plate 10 in. by 1 in. by 21 in. was cut into three bars 1 in. square. The plate with the enlarged ends was also cut into three. The enlarged ends were turned up true axially with

* FOUNDRY TRADE JOURNAL, April 16, 1931.

* FOUNDRY TRADE JOURNAL, January 30, 1930.

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the centre line of the plate, the latter reduced in the centre to 1 in. square, leaving two opposite sides black. A further set with bars 2.2 in. dia. and plates 2 in. thick was cast from another mixture. Dr. Swift kindly undertook to test the bars and also the broken halves from the transverse turned down for tensile tests. These would then be in line with the usual method of taking tensile tests from a casting. The results are given in Table I:—

TABLE I.—*Test of Cast-Iron Bars.*

1.2 bars.		Plates.		Enlarged plates.
Transverse. Tons per sq. in.	Tensile. Tons per sq. in.	Transverse. Tons per sq. in.	Tensile. Tons per sq. in.	Tensile. Tons per sq. in.
Medium 1.2 in. bars.				
27.3	21.53	33.7	23.46	21.48
34.46	21.97	33.9	22.76	21.42
—	—	33.4	22.66	18.10*
Large 2.2 in. bars.				
29.8*	17.96	28.0	14.98	17.25
35.6	19.38	28.3	15.86	—
—	—	27.1	15.18	—

* Flaw.

Attaining Uniformity

It will be seen that the M-bars results were fairly uniform, but the transverse bars cut from the 2-in. plate showed a 15 per cent. decrease when compared with the load on the 2.2-in. dia. bar. Also the tensile tests turned from the broken halves of the 2-in. square bars show a loss of 17½ per cent. compared with those from the round bars. The single tensile-tested specimen, however, as 2 in. square, only shows a drop of 7.6 per cent. compared with the round bar. It would be unfair to base any conclusion on a single result, but it does help to strengthen the opinion expressed earlier on. There is also little doubt that with a reduction of C and Si (T.C., 2.9 per cent., Si, 1.8 per cent.) the breaking loads of the L-bars and plates would have been more uniform. The castings made from this metal are, however, subject to constant heavy vibration, and have great irregularity of thickness of metal together with jacketed cores not accessible. In short, it is an apt illustration of contention (1).

It is often stated that no test-bar can show the true structure of a casting with different sectional thicknesses. It is also true, at least with our present limited knowledge, to say one cannot calculate a mixture that will give uniform structure to such a casting. Yet every day mixtures for such castings are made. If that corresponds to the size of any of the test-bars, at least it is known if the structure sought is attained. One other point is often overlooked when discussing the lower strength per square inch of a thicker section, viz., that a 2-in. section at 15 tons per sq. in. is stronger than a 1-in. section at 20 tons per sq. in., and that the casting in tension would generally break in the thin strong section.

Low-Carbon Border Line Irons

(4) There is no doubt that failures due to a comparatively low sudden impact or a quick rise of temperature on the outside have called attention to a weakness sometimes present in these low-carbon border-line irons, which the present tests with their gradually-applied load do not reveal. This accounts for the interest displayed both on the Continent and the States in this question. A review of the position is given in the "Proceedings of the American Foundrymen's Association, 1934," page 479. Up to that time no suitable impact test for cast iron had been developed. In this connection *no test-bar that is not of the same section of the casting it represents is of any use.* For some years the writer

(*Concluded in next column.*)

Resistance to Grinding of Coals

At a meeting of the Institute of Fuel held recently in London, DR. HAROLD HEYWOOD read a Paper on "The Resistance to Grinding of Coals," dealing with an investigation which had as its primary object the determination of the fundamental principles involved in the crushing and grinding of coals and associated minerals, and to ascertain the relationship between resistance to grinding and other physical characteristics of the material. The objects of the research were to determine the most efficient method of disintegrating coals, which could then be used as a standard to compare the relative efficiencies of industrial crushers and pulverisers; and also to investigate simplified methods of determining relative resistance to grinding which could be used for routine tests on coals.

The most efficient method of disintegration was found to be the compression test on cubes of coal; crushing by impact of a falling weight and between crushing rolls had approximately equal efficiency under certain conditions, but, in general, the efficiency of these processes decreased as the energy applied to the crushing process was increased. The resistance to grinding was measured by the energy in foot-pounds required to produce one sq. ft. of new surface, and had been determined for six different types of coal, two anthracites, shale and pyrites. Hardness measurements were made on the coals by means of the scratch test and by means of an abrasion test. The relative hardness determined by these two methods was approximately the same for most coals, but cannel was shown to be exceptionally tough. The author pointed out that, unless unwarrantable assumptions were made, specific surface calculations were too complicated for industrial and routine testing, and sufficient accuracy for most purposes would be obtained by taking as a measure of the fineness the percentage of the product passing a specified sieve. The results of the tests were compared directly by using in each case the value for Barnsley soft coal as a standard.

The results of all the tests are given in Table I, enabling a direct comparison to be made. The similarity in the order of resistance to grinding is remarkably close for the brittle materials, considering the heterogeneous character of coals. It was anticipated that the scratch hardness and abrasion tests would be in agreement. The experiments showed that although the brittle materials are placed in the same order of relative hardness, cannel and carboniferous shale are exceptionally resistant to abrasion, although they are comparatively soft. The abrasion test therefore appears to be affected by the property of toughness. It is noteworthy that both these tests show that the two seams of anthracite have approximately the same hardness, so that the large variation in the values of the surface energy must be due to internal fissures in the anthracite from the Red Vein seam. The effect of these fissures becomes less as the particles are reduced in size. The abrasion test fails when the hardness of the material being tested approaches that of emery, the result for pyrites being useless except as a demonstration of this point. Although the attrition test is very inefficient, due to friction between the particles and the grinding surfaces of the mill employed, this test places the coals in approximately the same order of resistance to grinding as they are placed by the other tests.

TABLE I.—*Resistance to Grinding and Abrasion Expressed Relatively to the Values for Barnsley Soft Coal.*

Material.	Compression test.			Impact test. Surface energy.	Crushing rolls. Surface energy.	Attrition test.	Scratch hardness test.	Abrasion test.
	Compressive strength.	Surface energy.						
		Average.	Perp'r. only.					
Anthracite Gt. Mt... ..	1.10	2.94	1.61	1.45	1.09	5.33	1.70	2.35
Anthracite, Red Vein ..	0.47	0.37	—	—	0.84	1.72	1.75	3.03
Welsh steam	0.38	0.23	—	—	0.23	0.74	0.29	0.27
Barnsley Hards	1.10	1.09	1.19	—	1.09	1.11	0.85	1.24
Barnsley Softs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Illinois coal	0.45	0.55	0.67	—	0.86	0.87	1.10	1.00
Cannel	1.14	1.96	2.15	2.30	1.32	2.52	0.92	2.71
Carbonaceous shale ..	1.04	3.15	2.85	—	2.52	—	0.69	3.03
Shale	0.97	0.65	0.60	4.00	2.04	2.24	0.32	0.41
Pyrites	—	—	—	—	2.52	1.76	5.71	Abt. 82
Calcite	—	—	—	—	—	—	1.92	—

Company Meeting

Presiding at the annual meeting of the Birmingham Small Arms Company, Limited, held at Coventry, recently, SIR ALEXANDER ROGER (chairman) said that Wm. Jessop & Sons, Limited, and J. J. Saville & Company, Limited, the fine steel interests of the B.S.A. group, in which a large amount of capital was locked up, had made definite progress at home and in certain countries abroad, in spite of reduced purchases by Russia, almost complete cessation of buying by German customers, and the quota and other restrictions in France and other foreign countries. In 1933-34 sales in the home market, excluding sales to associated companies, exceeded those of the previous year by 38 per cent., and they recorded a further increase of 20 per cent., which had more than covered the fall in export business. The improvement in the home market had created a tendency for a steelworks to become an engineering shop, and in order to meet this position the machining facilities at Sheffield for medium and heavy work were being extended and would be running in the next few months. Extensions of the facilities for heat-treatment have had to be carried out, while their larger consumption of electricity had necessitated capital expenditure and was showing considerable economy. The tool group, concerned with the manufacture and sale of machine tools and small tools, had had a successful year. During the year the company had spent altogether £126,000 on new plant and machinery and reorganisation of lay-outs.

(*Concluded from previous column.*)

used a modification of the French shell test, viz., a falling weight of 35 lbs. (instead of 25 lbs.), starting with a drop of 6 in. and raised by increments of ½ in. till the bar broke. The test-bars were 1¼ in. square, moulded in dry sand and tested at 6-in. centres. The number and height of the drops depended entirely on the structure, which in turn depended on the section of the bar or, in other words, the cooling rate. With metal of T.C. 3.4 and Si 0.8 per cent. the 1¼-in. bar would be mottled and break with the first blow at 6 in., while a bar cut from the 2¼ down runner, cast from the same ladle, would be grey and need 25 to 30 blows to break them, sometimes at a height of 27 in. These results were confirmed a number of times over several years. The above four points are put forward for discussion and ventilation before the industry is committed to any new specification.

Cams for Looms

The operation of a modern power loom as used in the textile industry for weaving plain or patterned materials of all types depends very largely on the use of cams—or "tappets" or "wipers" as they are often called locally in the trade. These cams shown in Fig. 1 by their rotation impart reciprocating motions to the various levers which control the weave and so form the pattern in the product.

In the evolution of the loom the number of moving parts has been reduced to an absolute minimum so that a single cam is now made to control a number of operations, and the more complex the pattern to be woven, the more intricate the cam profile. This development offers a great mechanical advantage in that the greater the number of movements which can be controlled from one cam, the better is the co-ordination between these movements, and this is a vital factor since synchronisation of the loom movements is essential. On the other hand, more work is imposed on the individual cam, and problems due to wear begin to appear.

Although there are types of cams available in which by the use of loose pieces the cam profile can be varied at will according to the pattern required, it is more common to have a set of fresh cams for each set-up of the loom, the individual cams being made as iron castings. Most users favour the latter type of cam owing to its greater rigidity and reliability, there being no danger of breakdown due to loosening bolts and subsequent collapse of the cam profile.

Fig. 1.—Cam Casting for the Textile Trades made in Nickel Iron.

When the proper cam profiles have all been worked out for a particular pattern by the designers and the cams have been prepared, the time comes for setting up the loom. This is a delicate and tedious operation, and with a big modern power loom it often takes from two to four weeks to complete the set-up and to tune up the loom until the pattern is just right. In operation, any subsequent wear of the cam faces is liable to cause distortion in the pattern since the wear is magnified many times in the lever system. Serious wear thus leads to premature stoppage of the loom and to the loss of several weeks for re-setting and re-tuning. It is not surprising, therefore, that manufacturers are now turning with relief to the new nickel alloy cast irons for their cams on account of the proved high strength, long life and wear-resistance of the castings.

The Hardness Factor

With a suitable composition of iron, 1 to 2 per cent. of nickel is usually sufficient to give a substantial improvement in wearing quality and life. In the case of many cams, however, the loading is so heavy that the more highly alloyed high hardness cast irons have proved of greater interest and are, therefore, of more direct importance to the loom user. It should be explained that one of the most important effects of nickel in cast iron is that although small additions of nickel soften a hard casting by removing chill and hard spots, the nickel additions at the same time harden the matrix of the metal, thus hardening the casting as a whole, although it remains grey. The maximum hardness in an average casting is reached at about 5 per cent. of nickel when the castings, in addition to showing high hardness, are also very tough and dense and show an excellent resistance to abrasive wear.

These properties are not, of course, compatible with ready machinability and, where considerable machining is to be carried out on the casting before it is put into service, an alternative is available in the shape of heat-treatable low-nickel cast iron. This, while readily machinable as cast, is of such a composition that after machining it may be hardened for use by means of a simple heat-treatment consisting of an oil quench from about 875 deg. C. followed by tempering at about 350 deg. C. This treatment gives structures very similar to those obtained in the 5 per cent. nickel cast iron, but it is accompanied by some danger of distortion in the castings and is at the same time sometimes inconvenient. The hard 5 per cent. nickel cast iron is therefore generally used wherever possible.

Fig. 2.—Carpet Loom Cam Casting.

Carpet Loom Cams

Of special interest in this connection is a recent instance which occurred in connection with the carpet loom cams illustrated in Fig. 2. The loading on these cams is heavy and something more permanent than ordinary cast iron is necessary in order to avoid the long delays involved in re-setting the looms after wear has taken place. After considering the use of hard nickel cast irons for these cams, it was decided to use the lower nickel composition and after machining to harden by heat-treatment as described above. It has been found, however, in practice that although this treatment can successfully be applied to smaller cams some difficulties in handling the castings during the heat-treatment operation are likely to arise with larger sizes of cams, more especially since in these larger sizes sections are often thin in order to ensure lightness. To obviate the troubles in handling it was subsequently decided to use the 5 per cent. nickel cast iron hard as cast, thus eliminating any need for heat-treatment. It has been found that the castings can be made so accurately that little machining is required and no difficulty has been experienced in handling the castings from this point of view.

Cams of this type have now been in operation for six months or a year without showing any appreciable wear. This is a considerable advance over the service given by ordinary cast iron where within this period the trouble of distorted patterns was normally encountered. The user in this case has now standardised on hard nickel cast iron for all cams throughout the mill, and has stated definitely that from his experience "the service life of these cams will be at least double that of the ordinary soft iron cams. The working conditions here put these cams to a very severe test, and up to the present these have proved to be very satisfactory." This example is one of many in which nickel cast iron on account of its general quality and superior wear resistance has proved an economic material on account of the better service which it gives.

In addition to its wear resistance, however, nickel cast iron is particularly suitable for cams since such castings nearly always involve the juxtaposition of relatively heavy parts such as the boss and light sections such as webs or spokes. It is well known that such a combination frequently leads to trouble in ordinary iron castings. This trouble is found either in the foundry or in the machine shop as porosity in the thick sections or, on the other hand, chilled spots at the corners and edges of the light sections. With a suitable grade of nickel cast iron uniform castings are readily obtained with good machining qualities and density in all sections. These properties taken in conjunction with the excellent wearing quality of nickel cast iron render the metal eminently suitable not only for cams of all types but for many other parts involved in loom construction as, for examples, bushes, gears and couplings, where again the superior life and wearing quality of the iron is appreciated.—(Nickel Bulletin.)

Sheet Rolling

At a meeting of the Midland Metallurgical Societies, held recently, Captain Parkes initiated a discussion on "The Hot Rolling of Sheets," and pointed out that the art of sheet rolling was about 200 years old. With regard to modern practice, rolling was still largely done in this country on the well-known two-high type of mill, whilst in America various continuous types of mill were in use. Progress in the production of sheets have been such that it was now essential to specify the application for which the sheet was to be used in addition to the size and gauge. Continuing, the speaker pointed out that the output of sheets, including tinplates, amounted to more tonnage than any other form of rolled steel. Developments which had taken place within the speaker's experience were (1) replacement of cast-iron housings by steel housings, (2) use of larger rolls, (3) greater accuracy in roll design, and (4) preheating of rolls.

Rolls having a chill depth of ¾ in. to 1 in. had been found to have a long working life. The high quality of British sheets was largely due to the skill of the individual workman. In order to produce the best-quality sheet the speaker believed that it was necessary to have a cold finish.

Various speakers took part in the discussion, in the course of which it was pointed out that in this country there was still some difficulty in obtaining sheets with a specific grain size.

Mr. A. N. McQuistan, director and manager of the South Durham Steel & Iron Company, Limited, and the Cargo Fleet Iron Company, Limited, in a recent interview, stated that the new billet mill at Cargo Fleet, when constructed, would not only have an effect on the whole iron and steel industry, but would also check the importation of billets from the Continent.

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This Week's News in Brief

Trade Talk

MESSRS. JOHN READHEAD & SONS, LIMITED, South Shields, have secured an order to build a 9,000-ton vessel for a London firm of shipowners.

MESSRS. WILLIAM GRAY & COMPANY, of West Hartlepool, have booked a contract for another cargo steamer and have now four vessels on order.

THE NEW ADDRESS of the Steel Band Conveyor & Engineering Company, Limited, is Dawlish Road, Selly Oak, Birmingham. Telephone number: Selly Oak 1113-4-5.

MR. EDWIN MALLALIEU, 19, Grangethorpe Drive, Burnage, carrying on business at Jubilee Street, Manchester, brassfounder, is paying a first and final dividend of 11¼d. in the £.

THE EMPLOYEES of Messrs. Andrew Barclay & Company, Limited, Caledonia Works, Kilmarnock, have contributed during the year ended November 2 the sum of £87 7s. 6d. to hospitals and other charitable institutions.

THE TOTAL ANNUAL OUTPUT of 20,000 tons of tubes of the new Rumanian tube mill, under erection by the Malaxa locomotive works, of Bucharest, has been taken up by the oil companies. The mill is expected to start production next summer.

THREE TEES-SIDE FIRMS—Messrs. Pease & Partners, Limited, Head, Wrightson & Company, Limited, and the Tees-side Bridge & Engineering Company, Limited—share an order for 10,000 tons of railway chairs for the Southern Railway.

MESSRS. SMITHS DOCK COMPANY, LIMITED, have booked for construction at their River Tees Dockyard orders from Hull and Grimsby owners for nine steam trawlers for the Iceland and White Sea fisheries. In addition they have booked an order for a 600-ton coasting vessel.

THE REGISTERED AND HEAD OFFICE of Messrs. Baldwins, Limited, has been removed from Great Trinity Lane, London, E.C.4, to Shell-Mex House, Victoria Embankment, W.C.2 (P.O. Box 255). The London sales office is now at Shell-Mex House, Strand, W.C.2 (P.O. Box 286).

THE LONDON OFFICES of the Follsain Syndicate, Limited, Follsain Metals, Limited, Follsain Tubular Products, Limited, and Follsain Syndicate (France), Limited, have been transferred from Halifax House, 62-64, Moorgate, E.C.2, to Windsor House, 46, Victoria Street, Westminster, S.W.1.

THE STEEL TRADE in Austria disposed of nearly 40 per cent. more material in January to September last as compared with the parallel period of last year. This improvement has been largely due to the Government schemes for providing employment, especially by the building of a number of new bridges.

IN SEPTEMBER the Czecho-Slovak iron and steel industry produced 73,420 metric tons of pig-iron, the highest monthly total in the last three years. The previous highest total was 68,000 tons in June last. Steel output at 94,277 tons in September was slightly lower than in August, when it totalled 103,000 tons.

THE PARTNERSHIP BETWEEN Messrs. A. J. Tooley and H. E. Fookes, carrying on business as brassfounders, at Hale Street, Islington, London, N.1, under the style of the Alma Foundry, has been dissolved by mutual consent. Debts will be received and paid by Mr. Henry Ernest Fookes, who will continue the business.

MESSRS. LITHGOWS, LIMITED, Port Glasgow, have booked an order to build two motor tankers of 12,100 tons deadweight each for the Eagle Oil & Shipping Company, Limited. The machinery of the ships will consist of Diesel engines of the Burmeister & Wain type, built by Messrs. John G. Kincaid & Company, Limited, Greenock.

MESSRS. GLENIFFER ENGINES, LIMITED, Anniesland, Glasgow, have secured orders for four sets of Gleniffer high-speed Diesel engines to be installed in patrol boats, the hulls of which are being built in Canada. The Gleniffer engine is something new in high-speed Diesel engines and is the first of its type to be produced within the British Empire. It is a 16-cylinder unit arranged in V formation and develops 350 h.p. at 900 r.p.m.

MESSRS. BLYTHSWOOD SHIPBUILDING COMPANY, LIMITED, Scotstoun, Glasgow, have received orders for two oil tankers, each of 12,000 tons, for the Anglo-Saxon Petroleum Company, and two tankers of the same size for the Eagle Oil & Shipping Company, Limited. The machinery, consisting of single-screw Diesel engines, will be built by Messrs. John G. Kincaid & Company, Limited, Greenock. The total value of the contracts is over half-a-million stirling.

PLANS HAVE BEEN LODGED by Imperial Chemical Industries with the Irvine Dean of Guild Court for the erection of a new explosives factory at Irvine Harbour. Building operations are expected to be started before the end of the year. A large amount of labour, male and female, will be employed. There is no connection between this development and the announcement made recently that the Government intend to begin the manufacture of T.N.T. at their War Office factory at Irvine next year.

"INABILITY OF THE OFFICERS of the company to agree as to the conduct of the business" was given as the cause of the failure of the Birchfield Foundry Company, Limited, of Aston, at the first meeting of creditors on November 7. The order for the winding-up of the company was dated October 15. It was decided that no application should be made to the Court for the appointment of a liquidator other than the Official Receiver. Gross liabilities amounted to £1,474, with £666 15s. expected to rank. Net assets, after deducting the claims of preferential creditors, were £218 18s. 9d.

THE ANNUAL DINNER of the London Branch of the Institute of British Foundrymen will take place on Friday, December 6, at Charing Cross Hotel, London, W.C.2, at 7.15 for 7.45 p.m. The principal guest will be Mr. P. J. Hannan, the newly-elected Member of Parliament for the Moseley Division of Birmingham. The following artists have been engaged to provide after-dinner entertainment:—Edwin Spencer, baritone; Marjorie Holmes ("The Sunshine Girl"); Jack Rowlands, conjuror; Dorothy Holden, who is one of the B.B.C. accompanists; and Leonard Henry, the famous radio entertainer. As it is expected that there will be a large demand for tickets, early application is strongly recommended. Tickets may be obtained from Mr. H. W. Lockwood, London Branch-Secretary, Messrs. Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, London, E.C.2.

Company Reports

British Oxygen Company, Limited.—Interim dividend of 7 per cent. on the ordinary capital.

Drake & Gorham, Limited.—Interest on debenture stock, £2,972; loan interest, £397; taxation, £525. Deducting amount brought in, £592 is carried forward.

Guest, Keen & Nettlefolds, Limited.—Interim dividends at the rate of 5 per cent. per annum, free of tax, on the first and second preference stock and on the ordinary stock.

Birmingham Aluminium Casting (1903) Company, Limited.—Profit to July 31, £31,141; brought in, £26,603; preference dividend, £166; ordinary dividend of 10 per cent., £23,012; staff fund, £3,000; special depreciation, £5,000; dividend fund, £5,000; carried forward, £21,565.

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Bath Foundries, Limited, 47, Milsom Street, Bath.—Capital £5,000. Metal and alloy founders, etc. Directors: A. W. Wills, H. J. Coward, R. Membery, A. C. Phippen, A. J. Morgan and C. F. Morgan.

THE ANNUAL DINNER of the Scottish Branch of the Institution of Structural Engineers was held in the Grosvenor Restaurant, Glasgow, on November 15, Mr. A. S. Kinnear, chairman, presiding. Mr. J. Thomson, proposing the toast of the Institution, said that, although the Scottish Branch was only in its fifth session, it now has a membership of 160, while the total membership was over 3,000. The importance of the Institution was recognised last year by the granting of a charter which placed it on an equal footing with some of the older bodies.

Personal

MR. W. KIRTLEY, M.I.Mech.E., has joined the staff of A.R.M., Limited, Redheugh Foundry, Gateshead-on-Tyne, as sales manager.

MR. JAMES ORR, B.Sc., has been appointed principal teacher of electric welding at Stow College, Glasgow, by the Education Authority.

MR. G. H. EVESON, of Messrs. Eveson Bros. (1928), Limited, galvanisers and enamellers, Lye, Stourbridge, has been elected Mayor of Stourbridge.

DR. A. B. EVEREST is to read a Paper on "Nickel Alloys in Industry" before the South Staffordshire Chemical and Scientific Society on Friday.

MR. CHARLES EDWARD WILLIAMS, chairman of Messrs. John Williams & Sons (Cardiff), Limited, ironfounders and constructional engineers, has been made a Justice of the Peace for the City of Cardiff.

MR. AUGSTEIN, director of Metalinventio of Prague, is arriving in London to-day (Thursday). Mr. Augstein is interested in acquiring the selling rights of British foundry equipment in Czecho-Slovakia.

IN THE OFFICES of Messrs. Jones & Campbell, Limited, Torwood Foundry, Larbert, last Monday, Mr. Ian Yorkston, who is leaving to take up a position in Manchester, was made the recipient of a wrist watch as a token of esteem and regard by the members of the Torwood Foundry staff. Mr. J. N. Reid made the presentation.

Will

ELLIS, J. V., of Whitehaven, ironmaster, late director of the United Steel Companies, Limited £12,959

Obituary

MR. G. A. TAYLOR, a director of the firm of Taylor & Sons, Limited, of Briton Ferry, and a brother of the late Mr. Fred J. Taylor, died on Thursday.

MR. JAMES MARCHANT, who died in Glasgow on November 10, at the age of 84 years, was for 54 years employed as patternmaker with Messrs. Barry Henry & Cook, Limited, Aberdeen. He was a well-known personality in engineering circles.

Forthcoming Events

NOVEMBER 29.

The Iron and Steel Institute:—Joint meeting with the Staffordshire Iron and Steel Institute at the James Watt Memorial Institute, Birmingham, at 6.30 p.m.

Institute of British Foundrymen

NOVEMBER 22.

Lancashire Branch (Junior Section):—"Practical Foundry Experiences." Paper by J. Sherwood at the College of Technology, Sackville Street, Manchester, at 7.30 p.m.

NOVEMBER 23.

Newcastle-upon-Tyne and District Branch:—"The Properties of Foundry Coke." Paper by W. E. Mordecai. Joint meeting with the Coke Oven Managers' Association at the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

Scottish Branch:—"Locomotive Castings." Paper by H. Lowe at the Heriot-Watt College, Chambers Street, Edinburgh, at 4 p.m.

NOVEMBER 27.

Preston Section:—"Insight to Modern Sand Testing." Paper by W. D. Knagg, at the Technical College, Corporation Street, Preston, at 7.30 p.m.

NOVEMBER 30.

East Midlands Branch:—"Some Properties of Mould and Core Materials at High Temperatures." Paper by F. Hudson, at the Technical College, Derby, at 6 p.m.

Lincolnshire Section:—Discussion of Local Problems at the Technical College, Monks Road, Lincoln, at 7 p.m.

DECEMBER 6.

London Branch:—Annual dinner at the Charing Cross Hotel, London, W.C.2, at 7.15 for 7.45 p.m.

Birmingham, Coventry and West Midlands Branch:—"The Moulding of Light Castings by means of Strickles." Paper by T. W. Trayherne, at the James Watt Memorial Institute, York House, Great Charles Street, Birmingham, at 7.30 p.m.

Wales and Monmouth Branch:—"Electric Steel Foundry Practice." Paper by R. J. Richardson, at the Y.M.C.A., Llanelly, at 6.30 p.m.

The Institute of Vitreous Enamellers

DECEMBER 5.

Manchester:—"Sandblasting." Paper by F. W. Wilson, at the Y.M.C.A., Peter Street, Manchester, at 7.30 p.m.

XUM

THE "ROCKET" PATENT CORE MAKING MACHINE

Manufactured in 3 Standards

Sizes :—

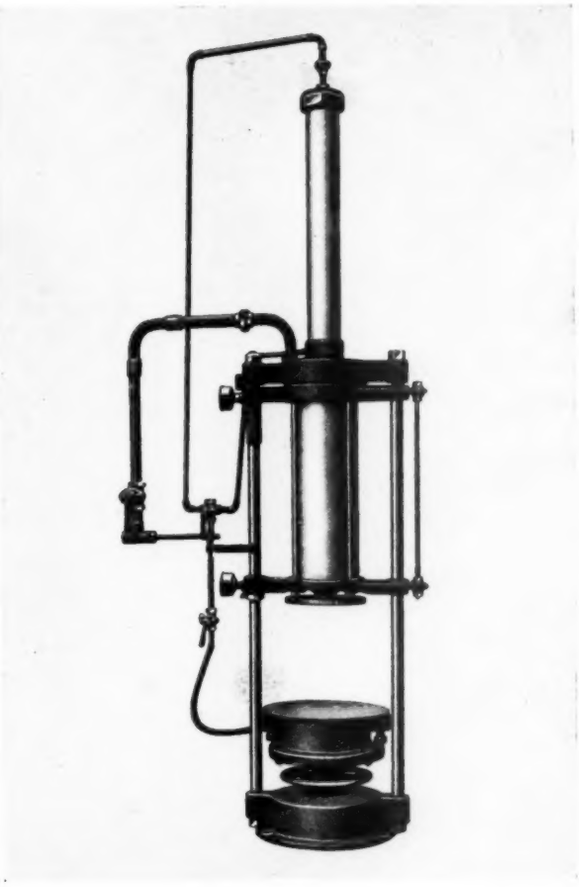
15 lb. Sand Capacity.
45 lb. Do.
100 lb. Do.

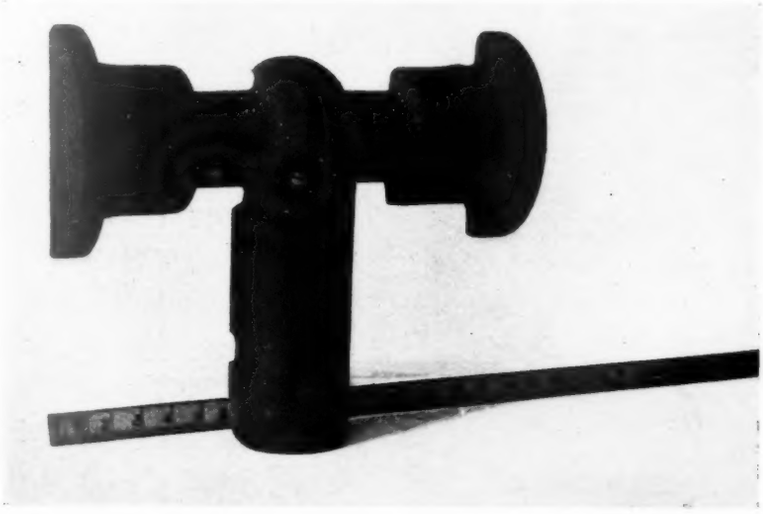
No moving mechanism in the Sand.

Repairs negligible.

Air consumption barely exceeds volume of sand used.

No foundations required.





Untouched photograph of Core produced on the machine illustrated above.

FOUNDRY ENGINEERS LTD.,

Telephone : 61459 Halifax **HALIFAX, YORKS.** Telegrams : "FEL," Halifax

Raw Material Markets

There was little surprise at the decision of the Cleveland ironmasters to raise quotations by 2s. 6d. to 2s. 9d. per ton. This step was expected following upon the advances made by the Central Pig-iron Producers' Association. The manufacturers of hematite may also raise their prices in the near future.

Pig-Iron

MIDDLESBROUGH.—The new prices of Cleveland foundry and forge pig-iron will have little effect for some considerable period, for most of the iron available over the next half-year has already been accounted for. Current quotations for No. 3 Cleveland G.M.B. foundry grade are 70s. per ton delivered Middlesbrough and Falkirk, 72s. delivered North-East Coast, and 73s. delivered Glasgow. A premium of 2s. 6d. per ton is charged for No. 1 foundry iron, and No. 4 foundry and No. 4 forge are both 1s. per ton less than No. 3. In order to satisfy the requirements of consumers, pig-iron is having to be brought in from Midland areas.

Fears that the price of hematite will be raised are being expressed in this district, but it is stated in official quarters that no such move is being contemplated at the present time. Manufacturers have disposed of most of their output until the end of next June, and the demand continues to be heavy. Consumers are in the market for both prompt and forward delivery. Fixed minimum selling prices to home consumers are still based on No. 1 East Coast hematite at 71s. per ton delivered Middlesbrough, 72s. on Tyneside, 73s. 6d. North-East Coast, 74s. Scotland, 78s. 6d. Sheffield, and 84s. 6d. Birmingham.

LANCASHIRE.—Forward contract buying is finding little favour in this area, and as the majority of consumers have covered their needs for a considerable period ahead, it seems likely that conditions will continue to be quiet for some time. The light-castings section of the trade continues to have satisfactory requirements, and the demand from textile-machinery manufacturers has increased. Local jobbing foundries, machine-tool makers and heavy electrical engineers all have satisfactory requirements. Quotations are very firm, with Staffordshire, Derbyshire and Lancashire brands of foundry iron all quoted for delivery in the Lancashire price zone at 78s. per ton, Northamptonshire at 76s. 6d., and Scottish No. 3 at about 83s. Hematite prices are unchanged, but an advance is not improbable. East Coast is at 80s. to 81s. per ton, and West Coast is at 81s., both delivered in the Manchester area.

MIDLANDS.—The local ironfounders continue to have good requirements, and makers of both light and heavy castings are well employed, with bright prospects. There is little business being transacted at the revised prices, but a few orders have been placed for small tonnages. The Association prices delivered Birmingham and Black Country stations are 72s. 6d. for Northants No. 3 and 75s. for Derbyshire, Lincolnshire and North Staffs No. 3, these figures being subject to a graduated rebate to large consumers. Forge iron is receiving more inquiries at 5s. per ton below No. 3 foundry. Hematite pig-iron is also receiving more attention, but the controlled prices are unchanged at 83s. 6d. for East Coast No. 3, 84s. 6d. for West Coast mixed numbers, and 83s. for Welsh mixed numbers delivered to Midland stations, with 1s. 6d. extra for delivery into works. Special qualities of foundry iron for the general engineering trades continue to have a satisfactory demand, and prices vary considerably, according to quality, and are from £5 7s. 6d. to £7 10s. Medium-phosphorus is between 75s. and 80s. 6d., while low-phosphorus is at 90s., all delivered Birmingham district.

SCOTLAND.—New business in this area is scarce, but the general tone of the market is strong. Deliveries are on a good scale. Official minimum prices are 74s. per ton f.o.t. furnaces for No. 3 foundry and 2s. 6d. per ton extra for No. 1. No. 3 Cleveland iron is now quoted at 70s. f.o.t. Falkirk and 73s. f.o.t. Glasgow. The light-castings makers are taking up large tonnages of both English and Scottish brands of iron. Local steelworks are active, with good prospects. Quotations for steel-making irons are unchanged as follow:—Mixed numbers Scottish hematite, 73s. 6d.; mixed numbers West Coast hematite, 74s.; mixed numbers East Coast hematite, 74s.; basic, British and Indian, 70s., less 5s. rebate, all delivered f.o.t. steelworks here.

Coke

The call for supplies of cupola coke is very strong, and delay in deliveries is reported. For delivery in Birmingham and district best Durham coke is on offer at from 37s. 6d. to 41s., with other qualities at about 35s. to 36s. Welsh coke is being offered at from 33s. 6d. to 45s. Scottish low-ash coke is available in small quantities at 41s. 6d. per ton.

Steel

Great activity continues to rule in the steel market, and there is no relaxation in the pressure from consumers to secure deliveries, says the official report of the London Iron and Steel Exchange. All departments of the industry are well employed, and in some cases works have been obliged to withdraw from the market, as their output has been sold for many weeks to come. In the semi-finished steel department, an acute stringency exists, and consumers find difficulty in placing fresh business. Many of the producing works are unable to accept orders, as their output has been sold in some cases well into next year, while others are only able to give far forward delivery, and for the most part are reluctant to commit themselves. The increase in the imports of Continental semi-finished steel, however, should help to relieve the position. The producing works in practically all sections of the finished materials department are busily employed, and in some instances are falling behind in deliveries. The recently-announced shipbuilding and railway orders will provide a heavy tonnage of additional orders for the steelworks, and will ensure active employment for some time.

Scrap

The expected rise in the price of heavy steel scrap has not yet taken place, but sellers are in a strong position. On the Cleveland market small tonnages of steel scrap are being taken up at 52s. 6d. per ton, which is also the price for ordinary heavy cast iron. An advance is also anticipated for the latter, for the demand is in excess of supply. Clean light cast iron is up to 45s. A firm tone prevails on the South Wales market, but the demand is a little quieter. A good demand exists for heavy mild-steel scrap in furnace sizes at 60s. Heavy cast iron in large pieces and furnace sizes is quiet, but steady at 54s. to 55s. Good cast-iron machinery scrap in foundry sizes has a small local sale at 57s. 6d. to 60s. per ton. The Midland market continues to be active, and prices are firm. Heavy machinery metal, broken into cupola sizes, is at 47s. 6d., and short, heavy steel scrap, as used in the foundries, is at 57s. 6d. delivered works. All classes of scrap on the Scottish market are on offer at very firm prices, but no advances have, as yet, been made. First-class heavy cast-iron machinery scrap is scarce, and is quoted at 61s. to 62s. 6d. per ton, with about 5s. per ton less for ordinary cast iron. Heavy mild-steel melting scrap in furnace sizes is at 50s. per ton, with 5s. per ton less for heavy basic or heavy iron and steel scrap mixed.

Metals

Copper.—This market has shown a firmer tendency following the General Election. Consumers are now enabled to take a more settled view of the future, and the October statistics, also, have influenced the market in its recovery. Consumption in this country is at a high level. According to unofficial figures for October, the world stocks of refined copper have decreased by 35,100 short tons, and they now stand at 394,250 tons. The latter figure excludes warehouse stocks of about 100,000 tons. Stocks in the United States declined by 14,700 tons, and the stocks in other countries were lowered by 20,401 tons.

Daily market prices :—

Cash.—Thursday, £35 6s. 3d. to £35 7s. 6d.; Friday, £35 12s. 6d. to £35 15s.; Monday, £35 8s. 9d. to £35 10s.; Tuesday, £35 7s. 6d. to £35 8s. 9d.; Wednesday, £35 6s. 3d. to £35 7s. 6d.

Three Months.—Thursday, £35 12s. 6d. to £35 13s. 9d.; Friday, £36 to £36 1s. 3d.; Monday, £35 16s. 3d. to £35 17s. 6d.; Tuesday, £35 15s. to £35 17s. 6d.; Wednesday, £35 13s. 9d. to £35 15s.

Tin.—Tight conditions continue in the tin market. Shortage of prompt supplies, both in this country and in the United States, is still pronounced. Nine hundred tons of Banka tin are due to arrive in London from the Dutch East Indies in the near future. The use that will be made of this is uncertain. The effect of the increased quota is certainly not being felt to any great extent, but hopes are still being expressed that the supply position will be relieved before the end of the year.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £234 to £234 10s.; Friday, £232 to £233; Monday, £231 to £232; Tuesday, £228 10s. to £229; Wednesday, £224 to £224 10s.

Three Months.—Thursday, £213 to £213 10s.; Friday, £214 to £214 15s.; Monday, £212 5s. to £212 15s.; Tuesday, £212 5s. to £212 10s.; Wednesday, £212 to £212 5s.

Spelter.—This metal continues to have a fair demand, but the depressed state of the galvanising industry remains a burden to any development. Some encouragement was given to the market by the publication of the United States figures, which were certainly an improvement on recent statistics.

Official quotations were as follow :—

Ordinary.—Thursday, £16 2s. 6d.; Friday, £16 7s. 6d.; Monday, £16 3s. 9d.; Tuesday, £16 2s. 6d.; Wednesday, £16 3s. 9d.

Lead.—This metal is expected to show increased activity now that the election is over. The extensive development schemes which the National Government is to carry out are bound to involve a large consumption of lead. The future of the British building industry is vital to this market, for it has been taking up large quantities for some considerable time. Consumption is reported to be increasing, although there has been a decrease in the amount of actual buying.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £17 17s. 6d.; Friday, £18 5s.; Monday, £18 3s. 9d.; Tuesday, £18; Wednesday, £17 17s. 6d.

WHEN THINKING OF
SANDBLAST
THINK OF
RICHARDSON'S
Established 1887.
We Supply Re-Conditioned & New
SAND BLAST PLANTS
AND
AIR COMPRESSORS.
Tilghman's, Room, Barrel, Chamber, Rotary Table, Dust Arrester, and Continuous Feed Barrel Plants.
Phone: MIDLAND 2281.
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SELECT YOUR MACHINE
FROM THE
LARGEST
STOCK OF HIGH-CLASS
SECONDHAND
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Practical Advice Free
THE COLEMAN FOUNDRY EQUIPMENT Co. LTD
156, STRAND, LONDON, W.C.2.

RESOURCES

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CK GANISTER

and the Armitage Mines, Deepcar

facture of Ground Ganister

NOTHING BETTER FOR THE LINING OF CUPOLAS THAN A REALLY HIGH CLASS GROUND GANISTER HAS EVER YET BEEN DISCOVERED — CHEAP "PRICE CUT" RUBBISH IS DEAR AT ANY PRICE

like Deepcar Ganister"

FINAL COST ——————————→ INFINITELY CHEAPER

With entire freedom from trouble and worry

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156, St. Vincent Street, C.2.

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Telegrams : Genefax, Glasgow.

XUM

RAW MATERIALS—PRICE LIST

(Wednesday, November 20, 1935)

COPPER

	£ s. d.
Standard cash	35 6 3
Three months	35 13 9
Electrolytic	39 5 0
Tough	38 0 0
Best selected	38 10 0
Sheets	66 0 0
India	49 10 0
Wire bars	39 15 0
Ingot bars	39 15 0
H.C. wire rods	43 5 0
Off. av. cash, Oct.	35 5 2 5/16
Do., 3 mths., Oct.	35 12 5 1/16
Do., Sttlmnt., Oct.	35 5 2 3/8
Do., Electro, Oct.	39 19 4 3/8
Do., B.S., Oct.	39 1 4 5/16
Do., wire bars, Oct.	40 6 6 5/16
Solid drawn tubes	10½d.
Brazed tubes	10½d.
Wire	6¼d.

BRASS

Solid drawn tubes	9¾d.
Brazed tubes	11¾d.
Rods, drawn	8⅝d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7⅞d.
Wire	7¾d.
Rolled metal	7⅞d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£ s. d.
Standard cash	224 0 0
Three months	212 0 0
English	224 10 0
Bars	225 10 0
Straits (nom.)	224 15 0
Australian (nom.)	224 10 0
Eastern	218 0 0
Banca (nom.)	225 0 0
Off. av. cash, Oct.	227 8 10 3/16
Do., 3 mths., Oct.	217 9 1 15/16
Do., Sttlmt., Oct.	227 6 11 1/16

SPELTER

	£ s. d.
Ordinary	16 3 9
Remelted	15 0 0
Hard	13 5 0
Electro 99.9	18 15 0
English	17 2 6
India	14 10 0
Zinc dust	19 10 0
Zinc ashes	4 15 0
Off. aver., Oct.	16 11 1 1/16
Aver. spot, Oct.	16 8 9 1/16

LEAD

	£ s. d.
Soft foreign ppt.	17 17 6
Empire (nom.)	18 15 0
English	20 0 0
Off. average, Oct.	18 4 2 5/16
Average spot, Oct.	18 4 2 5/16

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	24 7 6
Do., V.M. ex-whse.	25 8 9
Rods	29 0 0

ANTIMONY

	£ s. d.
English	79 0 0 to 80 0 0
Chinese, ex-whse.	66 0 0
Crude, c.i.f.	36 0 0

QUICKSILVER

	£ s. d.
Quicksilver	11 15 0 to 12 5 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	12 15 0
75%	17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£18 0 0 to £20 0 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	33 0 0
4/6% car.	21 15 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	33 0 0
Max. 1% car.	36 5 0
Max. 0.70% car.	37 5 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to 11 5 0
76/80% packed	£11 15 0 to 12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

South Wales—	£ s. d.	£ s. d.
Heavy steel	2 17 6	to 3 0 0
Mixed iron and steel	2 15 0	to 2 17 6
Heavy cast iron	2 14 0	to 2 15 0
Good machinery	2 17 6	to 3 0 0
Cleveland—		
Heavy steel	2 12 6	
Steel turnings	1 17 6	
Cast-iron borings	1 7 6	
Heavy cast iron	2 12 6	
Heavy machinery	2 15 0	to 2 17 6
Midlands—		
Light cast-iron scrap	2 7 6	
Heavy wrought iron	3 0 0	
Steel turnings	1 16 6	
Scotland—		
Heavy steel	2 10 0	
Ordinary cast iron	2 16 0	
Engineers' turnings	2 0 0	
Cast-iron borings	1 17 6	to 2 0 0
Wrot-iron piling	3 3 6	
Heavy machinery	3 1 0	to 3 2 6

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	29 0 0
Brass	19 0 0
Lead (less usual draft)	16 0 0
Tea lead	12 0 0
Zinc	9 0 0
New aluminium cuttings	72 0 0
Braziery copper	26 0 0
Gunmetal	27 0 0
Hollow pewter	155 0 0
Shaped black pewter	120 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	72/6
Foundry No. 3	70/-
,, at Falkirk	70/-
,, at Glasgow	73/-
Foundry No. 4	69/-
Forge No. 4	69/-
Hematite No. 1	71/-
Hematite M/Nos.	70/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	74/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	71/-
,, No. 3 fdry.	75/-
Northants forge	68/6
,, fdry. No. 3	72/6
,, fdry. No. 1	75/6
Derbyshire forge	71/-
,, fdry. No. 3	75/-
,, fdry. No. 1	78/-
Scotland—	
Foundry No. 1, f.o.t.	76/6
,, No. 3, f.o.t.	74/-
Hem. M/Nos. d/d	73/6
Sheffield (d/d district)—	
Derby forge	68/6
,, fdry. No. 3	72/6
Lincs forge	68/6
,, fdry. No. 3	72/6
W.C. hematite	86/-
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	78/-
Staffs fdry. No. 3	78/-
Northants fdry. No. 3	76/6
Cleveland fdry. No. 3	78/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	83/-
Clyde, No. 3	83/-
Monkland, No. 3	83/-
Summerlee, No. 3	83/-
Eglinton, No. 3	83/-
Gartsherrie, No. 3	83/-
Shotts, No. 3	83/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 12 6	to 9 15 0
Nut and bolt iron	7 17 6	to 8 7 6
Hoops	10 10 0	and up.
Marked bars (Staffs)	f.o.t. 12 0 0	
Gas strip	10 10 0	and up.
Bolts and nuts, ¾ in. × 4 in.	15 2 6	and up.
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	9 5 0	to 9 7 6
Chequer plts.	10 7 6	
Angles	8 7 6	
Tees	9 7 6	
Joists	8 15 0	
Rounds and squares, 3 in. to 5½ in.	9 7 6	
Rounds under 3 in. to ⅜ in. (Untested)	8 12 0	
Flats—8 in. wide and over	8 12 6	
,, under 8 in. and over 5 in.	8 17 6	
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 5 0	to 12 10 0
Hoops (Staffs)	9 7 0	
Black sheets, 24g. (4-t. lots)	11 5 0	
Galv. cor. shts. (,,)	13 5 0	
Galv. flat shts. (,,)	13 15 0	
Galv. fencing wire, 8g. plain	14 10 0	
Billets, soft	5 10 0	and up.
Billets, hard	6 17 6	to 7 2 6
Sheet bars	5 10 0	to 5 15 0
Tin bars	5 10 0	to 5 15 0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	12½d.
Rods	11½d.
Tubes	14d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.31
No. 2 foundry, Valley	19.50
No. 2 foundry, Birm.	14.50
Basic, Valley	19.00
Malleable, Valley	19.50
Grey forge, Valley	19.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.90
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.40
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	20/- to 21/-
,, furnace	16/6 to 17/9
Scotland, foundry	28/-
,, furnace	25/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/9
,,	28×20 ,,	37/6
,,	20×10 ,,	27/-
,,	18¾×14 ,,	19/6
C.W.	20×14 ,,	15/6 to 15/9
,,	28×20 ,,	33/6 to 34/-
,,	20×10 ,,	22/9
,,	18¾×14 ,,	15/9

SWEDISH CHARCOAL IRON & STEEL

	£ s. d.	£ s. d.
Pig-iron	£6 0 0	to £7 0 0
Bars-hammered, basis	£16 0 0	to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0	to £16 0 0
Blooms	£10 0 0	to £12 0 0
Keg steel	£30 0 0	to £31 0 0
Faggot steel	£18 0 0	to £23 0 0
Bars and rods dead soft, st'l	£10 0 0	to £12 0 0

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.		
Nov. 14 ..	35	6	3	inc.	6/3
„ 15 ..	35	12	6	„	6/3
„ 18 ..	35	8	9	dec.	3/9
„ 19 ..	35	7	6	„	1/3
„ 20 ..	35	6	3	„	1/3

Electrolytic Copper

	£	s.	d.		
Nov. 14 ..	39	5	0	inc.	5/-
„ 15 ..	39	10	0	„	5/-
„ 18 ..	39	10	0	No	change
„ 19 ..	39	5	0	dec.	5/-
„ 20 ..	39	5	0	No	change

Standard Tin (cash)

	£	s.	d.		
Nov. 14 ..	234	0	0	dec.	70/-
„ 15 ..	232	0	0	„	40/-
„ 18 ..	231	0	0	„	20/-
„ 19 ..	228	10	0	„	50/-
„ 20 ..	224	0	0	„	90/-

Tin (English ingots)

	£	s.	d.		
Nov. 14 ..	234	0	0	dec.	90/-
„ 15 ..	233	0	0	„	20/-
„ 18 ..	232	0	0	„	20/-
„ 19 ..	229	0	0	„	60/-
„ 20 ..	224	10	0	„	90/-

Spelter (ordinary)

	£	s.	d.		
Nov. 14 ..	16	2	6	dec.	2/6
„ 15 ..	16	7	6	inc.	5/-
„ 18 ..	16	3	9	dec.	3/9
„ 19 ..	16	2	6	„	1/3
„ 20 ..	16	3	9	inc.	1/3

Spelter (Electro, 99.9 per cent.)

	£	s.	d.		
Nov. 14 ..	18	15	0	dec.	2/6
„ 15 ..	19	0	0	inc.	5/-
„ 18 ..	18	15	0	dec.	5/-
„ 19 ..	18	13	9	„	1/3
„ 20 ..	18	15	0	inc.	1/3

Zinc Sheets (English)

	£	s.	d.		
Nov. 14 ..	24	7	6	dec.	2/6
„ 15 ..	24	10	0	inc.	2/6
„ 18 ..	24	10	0	No	change
„ 19 ..	24	7	6	dec.	2/6
„ 20 ..	24	7	6	No	change

Lead (English)

	£	s.	d.		
Nov. 14 ..	20	0	0	No	change
„ 15 ..	20	5	0	inc.	5/-
„ 18 ..	20	5	0	No	change
„ 19 ..	20	0	0	dec.	5/-
„ 20 ..	20	0	0	No	change

Imports and Exports of Pig-Iron, Iron and Steel Castings, etc., in October and the ten months, 1935, compared with a year ago.

	October.		Ten months.		October.		Ten months.	
	1934.	1935.	1934.	1935.	1934.	1935.	1934.	1935.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India ..	12,049	3,850	88,468	57,845	34,709	11,457	248,479	172,064
„ Foreign Countries ..	1,047	2,056	12,159	13,041	6,540	11,730	70,163	76,346
Total ..	13,096	5,906	100,627	70,886	41,249	23,187	318,642	248,410
Castings and forgings ..	217	317	3,230	2,618	5,317	11,339	80,495	71,744
Cast pipes and fittings	84	247	890	1,450	2,099	6,479	46,661	36,980
Stoves, grates, etc. ..	125	84	977	994	9,940	6,552	79,876	81,688
Baths ..	698	531	6,655	5,796	17,967	14,145	165 540	153,922
Hollow-ware, all kinds ..	141	248	1,919	2,155	9,090	15,090	110,879	142,608
Exports.								
Pig-iron, forge ..	115	451	1,025	1,065	516	1,583	4,331	6,810
„ foundry ..	6,012	7,401	59,068	76,985	21,632	24,901	202,324	266,225
„ acid ..	6,142	5,486	39,092	42,447	19,287	17,710	123,439	137,255
„ basic ..	—	10	832	829	—	36	2,725	2,650
Total ..	12,269	13,348	100,017	121,866	41,435	44,230	332,819	412,940
Castings and forgings ..	673	262	4,534	3,601	26,623	10,429	176,527	138,919
Cast pipes and fittings, up to 6 in. diameter ..	5,644	5,207	50,951	48,881	64,730	61,195	566,857	546,133
„ „ „ over 6 in. ..	4,730	2,116	31,409	28,091	36,076	23,241	234,020	228,276
Stoves, grates, etc. ..	881	1,013	7,242	7,315	45,616	52,507	349,621	371,047
Sanitary cisterns ..	349	271	2,539	2,564	9,217	8,336	73,519	75,463
Bedsteads, inc. tubes therefor ..	405	513	4,234	3,731	14,642	17,325	140,977	136,410
Cast hollow-ware ..	373	579	3,065	3,522	14,981	19,528	117,232	131,489

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COREMAKERS' Foreman seeks position; wide experience in oil engines, motor trucks, also general engineering and repetition castings; keen rate fixer; supervision of male and female labour. Good results guaranteed. Good organiser and live wire.—Box 478, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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YOUNG MAN, single, age 29, desires position as foreman or assistant anywhere abroad. Experienced. Guaranteed to get results. Iron; semi-steel; jobbing. Repetition. —Box 454, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ASSISTANT FOREMAN required for iron and brass foundry. Applicants should have technical as well as practical qualifications and be under 40 years of age. Write, stating full particulars of experience and wages required, to the Secretary, CONSETT IRON CO., LTD., Consett, Co. Durham.

ASSISTANT Foundry Foreman required for large foundry in the Midlands making repetition precision castings in grey iron. Good opening for young man—preferably one who has had experience in machine moulding.—Box 462, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ASSISTANT Foundry Foreman required for Malay. Unmarried; age 26 years. Experience in moulding and producing iron and non-ferrous castings essential. Some experience in steel castings a recommendation. Reply giving full particulars and salary required to Box ZG910, c/o DEACONS, 5, St. Mary Axe, London, E.C.3.

ASSISTANT Metallurgist required by a foundry producing light iron castings. Applicants must have sound knowledge of alloying and analysis. University graduate preferred. State age, experience and salary required, to Box L.183, c/o W. H. SMITH & SON, LTD., Manchester 3.

ASSISTANT Patternshop Foreman required for large repetition foundry in the Midlands. Preference given to young man who has had experience in making pattern equipment for machine moulding, preferably for the motor trade.—Box 464, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN Coremaker required, used to oil-sand cores and expert experience in use of core-applying machines. State full experience, age and wage required, to Box 480. Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SITUATIONS VACANT AND WANTED.—*Contd.*

MANAGER wanted for progressive grey-iron foundry in Midlands making engineering castings up to 3 tons weight. Good opportunity for practical man with tact and ambition. Write giving age, details of experience, etc.—Box 474, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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ONE new Cupola Installation by George Green, with cupola 3 ft. dia., complete with drop bottom, spark arrester, staging and motor-driven blower; absolutely new condition. Electrical equipment suitable for standard 3-phase current. Cheap to save removal.—ALEX. HAMMOND, Foundry Machinery Merchant, Slough.

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